PREFACE.

By the Special Committee of the Council on Standardisation.

Introduction.

FOLLOWING the practice of previous years, it was decided by the Council that each Local Section of the Institution should arrange at one of its meetings to discuss the subject of Standardisation. The ruling was to take effect during the 1932-33 session, the subject for discussion being selected by popular vote following the issue of a general memorandum to all members. The subject matter and discussion arising from it is published collectively in this issue of the *Journal*, and perusal of its contents is strongly recommended, not only in the interests of Institution members but of industrial enterprise in general.

One very significant fact emerging from the deliberations of members of the Institution is the variation of opinion which exists on the subject of Standardisation. It is apparent also that the manufacturing community as a whole is not as thoroughly acquainted with the work of national bodies such as the British Standards Institution as one would expect. On many points confusion is prevalent, the facts as brought to light through discussion between engineers with widely varying productive interests clearly indicating the value of a frank interchange of viewpoint.

By thus expressing themselves Institution members have performed a valuable service, and if the publication of their collective views were to achieve no other object, as a contribution to progress the work is more than justified. On the one hand it clears the air to a better understanding of Standardisation as it affects the production engineer, and on the other it establishes firmly the production engineer's authority in consultation on matters relating to standardisation in all its phases.

With a view to directing lectures and discussions along certain lines the Council invited the Papers Committee to draw up a memorandum on Standardisation, the memorandum being intended as a guide to the lines of investigation likely to be most useful. This memorandum which is given in full following this preface, was issued to all members and the various lecturers as indicating the Council's lines of thought at the moment, not with a view to curtailing anything lecturers or members had to say, but with a

view to finding from the discussions of the various papers whether there was any basis which would indicate that further action was necessary or would be desirable on the part of the Council.

As will be noted, the memorandum takes the form of six questions, each of which was amplified somewhat by the Papers Committee for the guidance of members. Taking these questions as they appear, and comparing them with the points raised in the various lectures and the discussions that ensued, it will be seen that each of the questions put in the original memorandum is particularly pertinent to the subject, as in one form or another they are constantly recurring throughout the entire consideration. With a view to emphasising these various points the following brief notes are given, albeit the close reader will find many more points of contact than can be conveyed in a short preface.

(1) *Standardisation : What Does This Mean ?*

Standardisation, as such, is often thought of as something that is final, whereas it should be looked upon rather as something which is subject to change but not at too short intervals. In standardisation, however, the main object is not so much that of limiting changes of design which experience may suggest as being desirable, but of limiting the number of designs, or specifications, which, in their general features, cover the same ground.

It is clear from the various discussions that prior to this subject coming under review some ambiguity of thought was present amongst members of the Institution as to just what Standardisation really meant. It is also clear from a careful perusal of the reports that in this one respect alone the discussion of Standardisation has already had a beneficial effect.

(2) *Are Production Engineers Sufficiently Familiar with the Standardisation that has Already Been Accomplished ?*

In the memorandum the attention of members was called to the fact that much had been done by way of standardisation as it affected the engineer. Careful reading of the discussions that followed the lectures shows that while members have a fair appreciation of the work already accomplished, points here and there suggest that a full knowledge of the subject is not so common as seems desirable.

The information imparted during the various lectures as to what has already been accomplished is sure to germinate thought along the lines desired by the Council. The data presented in several of the lectures provides one way of getting further acquainted with the work already done, and to carry matters a stage further the Committee specially desires to call the attention of all members to the Handbook of Information and Indexed List of British Standards Specification issued yearly by the British Standards Institution. This index should be in the possession of all production engineers.

(3) *What are the Fundamentals of Standardisation?*

This is probably the most difficult question asked in the original memorandum. It was dealt with very briefly by the Committee and the various lectures and discussions have raised a number of points that may be considered as fundamentals additional to those already put forward. The Committee does not wish to be dogmatic in such matters. At the same time they wish to emphasise that the last paragraph of the memorandum contains the two most vital fundamentals that affect standardisation.

(4) *Can Standards assist the Production Engineer, and, if so, What Should be Standardised?*

Practically every point raised in this section of the original memorandum was reviewed either in the lectures or the discussions that followed them. Many other points of contact were also disclosed and any careful reader of the papers must be forced to the conclusion that wise standardisation, whether internal or external, can be a most valuable help to the production engineer.

Instances of this emerged during discussion at various sections. At Birmingham it was mentioned that attempts to produce threaded work to standard limits had led to the use of ground thread taps and with these considerably more work was obtained. The effect on production of standardising a larger pressure angle than 14½ degrees for gear teeth is another point which emerged through the medium of discussion in Birmingham. On machines such as the Fellows gear shaper which operate at a speed of 600 strokes per minute the relieving of the tool during the return stroke is a vital matter, a point about the larger pressure angle being that it permitted of reducing the amount of relief to a minimum, thus solving a really difficult mechanical problem.

Commenting upon the second portion of this particular question, namely, "What should be standardised," there is little, if anything in the various discussions that indicates what is desired, except in respect to what one may term internal standards.

(5) *Could we Obtain Closer Co-operation Towards Standardisation Than Already Exists?*

On this point the lectures and discussions are full of hints that closer co-operation is desirable. This co-operation may be brought about in one or more of several ways. The one way which appears to indicate that it would bring about the quickest results is that all members shall make a close study of what has already been accomplished by way of standardisation, and, following this, should then put forward to the Council their ideas of what further measures could be usefully proceeded with from the point of view of the production engineer of the future.

(6) *Is it Possible to Forecast Lines of Action for the Future of Standardisation?*

It is made quite clear by the various papers and by the views of members during discussions that the time is ripe for the Institution of Production Engineers to take a more prominent part in this vital subject of Standardisation. The view is strongly held by many members that the Institution should be more prominently represented on the various Committees and Panels of the British Standards Institution. Further than this, it is suggested that a Standing Committee should be appointed to survey the whole of the ground covered by standardisation and its effects on production engineering. This side of the subject is now being considered by the Council of the Institution, and it has already been decided that a Standing Committee is to be appointed.

Conclusion.

In conclusion the Council of the Institution of Production Engineers desire earnestly to thank all those who lectured before members of the Institution and also those who joined in the subsequent discussions. Also to state that during the current session, 1933-34, the work of the Institution is to be carried a stage further by discussion at all Local Sections of the subject of "Estimating Methods." The papers and discussion emerging from deliberations on this subject will be published collectively in due course and should prove a valuable addition to the work of the Institution.

December, 1933.

STANDARDISATION AS APPLIED TO PRODUCTION ENGINEERING.

Memorandum by the Papers Committee approved by the Council of the Institution for the information of members taking part in the discussions on Standardisation, during the session 1932-33 *as a guide to the lines of investigation likely to be most useful.*

(1) Standardisation : What Does this Mean ?

IN modern industry, Standardisation has aroused considerable interest, and it is generally agreed that standards are necessary so that the quality, value, and performance or service, of the parts or products being made can be assessed.

(2) Are Production Engineers sufficiently familiar with the Standardisation that has already been accomplished ?

Among the better known details that have already been standardised we have many materials, tools, drawings, methods, and products. The first four of these are obviously controlled to a certain extent by the last item, namely, by the product that has to be manufactured.

Practically all materials we use in the engineering industry are covered by standardisation already accomplished through the British Standards Institution. If our industry needs further of these standards, it is only a case of getting this Institution interested, and they can make the necessary moves towards obtaining co-operation of parties concerned.

The standardisation of details such as keys, drills, splines, limits, and many others, has already proved a great asset to those who are familiar with them, but it is probably true to say that many of these standards are not sufficiently known or appreciated by those who should be using them.

(3) What are the fundamentals of Standardisation ?

The standardisation of materials, details, and in many cases, whole lines of products, has proceeded during the last ten years at a fairly rapid rate. Such standardisation helps to effect maximum interchangeability ; serves to stabilise production, and in many cases, assists in reducing the cost of manufacture. Standardisation also helps the trader, who can reduce his stock of components, and furthermore, enables him to render rapid service to the user.

One objection that is often raised to standardisation is that it tends to hold back new designs, but obviously this depends on the far-seeing consideration of the designer himself.

Detail improvements can usually be adopted without altering the adaptability of the unit construction, and such improvement can frequently take place and still be interchangeable with the older designs.

One of the fundamentals of standardisation is to stabilise designs or materials, so that they can be economically made and used. It follows from this that another fundamental is that all engineers should have full knowledge of the standardisation that takes place.

(4) Can Standards assist the Production Engineer, and if so what should be standardised ?

This is a question that is well worthy of a full discussion. Any standards which help to save waste in industry should be considered, and if possible to reach agreement, should be adopted.

Starting with the drawings, there is still much to be done in standardising the methods of projection on the drawings themselves. There is still a definite need for a unified method of dimensioning, and also, of indicating finishes.

This question of drawings is highly important because to-day a large number of firms are sending their drawings out to various firms, who supply them with details.

Whilst there is still much scope for the Standards Institution to cover in general engineering, there is a wider field to be covered in what may be termed "INTERNAL WORKS STANDARDS." Quite obviously, this latter only concerns individual firms, but it is well worthy of the fullest consideration.

So far as machine tools are concerned, such items as spindle noses of machine tools ; height of work table ; direction of slide movement with clockwise or anti-clockwise hand wheel motion ; chuck adapters ; and standardisation of cutting tool sections, all need consideration.

Another vital subject for standardisation is that of engineering catalogues. The catalogue that is standard in size and will fit into a standardised cabinet, is one that is likely to be kept and used. All will appreciate that a catalogue that is not used is not of much value.

(5) Could we obtain closer co-operation towards Standardisation than already exists ?

If we decide that standards are of assistance to our industry, a full and free discussion on what standards are required, and how to get closer co-operation with a view to obtaining these standards, will undoubtedly benefit the industry we serve, and in particular, the members of our Institution. A discussion on this side of the subject will most certainly bring out many points, which, once they are known, would ensure action being taken towards that co-operation which is necessary before standardisation can take place.

(6) Is it possible to forecast lines of action for the future of Standardisation ?

The future is always difficult to forecast, but if we are to have efficient standardisation we must look as far into the future as we possibly can with a view to stabilising or standardising designs for as long a period as is possible, without cramping progress.

Whilst it is difficult to forecast that future, full and free discussion on possible lines of development will undoubtedly clarify ideas as to what standardisation appears to be possible. Without a look into the future, standardisation will be cramped, and/or inefficient.

4th June.

STANDARDISATION IN RELATION TO PRODUCTION ENGINEERING.

Paper presented to the Institution, London and Yorkshire Sections, by C. le Maistre, C.B.E., Director, British Standards Institution.

BEING so little in touch with the production side of engineering, I feel that in referring to the subject of standardisation as it affects your department, I cannot do better than follow the lines indicated in the quite excellent memorandum adopted by your Council, and dated the 4th June, which was kindly sent me for my guidance.

(1) Standardisation : What does this Mean ?

First of all as to the meaning of standardisation or rather "industrial" standardisation, for we are not, of course, concerned here with the legal standards either in their preparation or maintenance.

Standardisation can be divided roughly speaking into three categories : First, standards employed to ascertain the quality of materials or performance of machinery and which also give a method of testing, for instance, to ascertain as to whether a so-called 100 h.p. motor really is what it claims to be ! Secondly, those standards dealing with exact sizes, where it is desired to secure interchangeability of component parts. One aspect of this is the reduction of the variety of pattern of articles for one and the same purpose and concentrating manufacture on those sizes which fulfil ordinary everyday demands.

It is said that in this country we live on diversity, but diversity may go too far, for it is acknowledged that there is an immense amount of capital locked up in slow moving stocks which both manufacturers and merchants are forced to keep on account of this great diversity.

This question of simplification is a most important one and, as you all know, has received much attention in America, that country where they have been so prodigal with their materials. We in this country have not, by any means, neglected this side of industrial standardisation, for there is the reduction of steel sections to 114, of tramway rail sections from 75 to five, and of mine rails from 500 to 14 sections. Moreover, much has been done by individual firms and

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trade organisations to save some of this preventable waste and so release capital for more remunerative employment in other directions.

And thirdly, those standards which have relation to factors of safety used in design for construction and installation work. These standards of practice ensure safety of the workers and the public by making provision for adequate strength and appropriate quality of materials. An example of this is the B.S. specification for structural steel in buildings, giving a saving of weight of some 20 per cent. in the steel used. In some countries such work is known as a code. The American boiler code for instance, which is so well known all over the world that the boiler makers of this country find themselves sometimes badly handicapped in their export trade as the American code is so often quoted. This country has lead the world in boiler design and yet there is no British boiler code. This situation is fortunately now well on the way to being rectified as our boiler committee, formed in June, 1931, will soon be ready to issue the results of some of its work. Eventually our hope is that imperial boiler rules may be agreed upon.

These three categories with the few examples added will, I hope serve to explain the meaning of industrial standardisation, so far as I can interpret what I have been privileged to see of its development as a national movement during the past thirty years.

(2) Are Production Engineers sufficiently familiar with the Standardisation already accomplished ?

If this question relates to nationally agreed standards, then I wonder whether all you gentlemen are familiar with the B.S. specifications relating to the mechanical field which have now been issued. A glance at our latest indexed list, will I fancy astonish some of you who may not realise that for the past few years, with the fullest co-operation of the Institution of Mechanical Engineers, a very strong and representative mechanical industry committee, under the chairmanship of Mr. W. Reavell, of Ipswich, with a large number of technical committees under it, has been very actively at work.

I will not weary you with a recital of the complete list of the specifications nor even with those applicable to the mechanical industry. I have a few lists of the latter here and you will be very welcome to them. Rather will I refer in some little detail to a few which may perhaps be of particular interest to the production engineer. You will see in the list that in addition to having dealt with the such fundamental problems as screw threads, limit gauges, keys and keyways, splines and serrations, we have also dealt with rolled and drawn sections for automatic machines. It is, however, during the last five years that the work has tremendously increased.

The committees are dealing, as I have already mentioned, with

boiler specifications and are approaching the stage of publication. The first specification will be for Lancashire and Cornish boilers and other specifications will follow. It must be remembered, however, that in all this boiler work there are certain fundamental principles in which the insurance companies are naturally vitally interested, which run right through the whole work. It has taken a considerable time to reach agreement on these formulæ and factors of safety and therefore, although this work has been under consideration for some time, an immense amount of spade work has had to be carried out before anything could be publicly issued. The question of the boiler code is of interest to the production engineer only indirectly though of great interest to the industry of the country generally.

A particularly interesting specification is the one dealing with identification colours for pipes for noxious gas containers, and that leads of course to the standard schedule of colours, which at the present deals only with colours for paints and varnishes. This will in due course be enlarged to deal with the full range of colours required for all industries, and we hope the schedule will eventually become an Empire standard. Such a proposition was fully discussed at the Ottawa conference. I draw attention to this standard schedule of colours because of its scientific basis. There are, as you know, numbers of colours in constant demand, but unfortunately there are so many variations that if half-a-dozen firms were asked for any one of the colours, it is probable that as many as six different shades would be supplied. It is very necessary therefore, to have some standardisation. It will be a means of introducing what may be termed a colour language for the whole Empire, and as no doubt you will agree, be invaluable to trade. A colorimetric analysis of each colour has been included, thereby securing a permanent record of the colours for future use, and which will be helpful to record any change in the standard patterns themselves.

The instrument used at the National Physical Laboratory is the Guild colorimeter, and depends on the principle that colours of any possible hue and, within certain limits, of any possible saturation may be produced by mixing three spectrum colours in suitable proportions, the shade being expressed as a percentage of an arbitrary standard of shade. A surface of magnesium oxide illuminated at an angle of 45° to the surface and viewed normally has been adopted for this purpose by the N.P.L. Such a standard colour scheme will supply an accurate means in exchange of colour information. It is understood that about 200 colours will be necessary. At the present we have only 68, but it is hoped with the help of the British Colour Council that the full schedule will not be long before it is completed.

Now as to standards more nearly concerned with your own work. The B.S. specification for drawing office practice is useful, and no doubt most of you are familiar with it. It deals with the size of

drawings and tracings, the position of drawing numbers, indications of scale and methods of projection, with types of line and writing, as well as the indication of materials on drawings. They also give abbreviations. I do not think, at the moment, that there is any minimum size for figures. It might be a useful addition.

Machine tool equipment, which of course must go far to facilitate production, is giving considerable work to the various technical committees. I might quote one of the most important which is the gearing specification.

This was fully described by Mr. Cook, my assistant in charge of the mechanical work, in a paper that was read before the Institution of Mechanical Engineers at Southampton last November. As you know this question has received a good deal of attention, not only in this country, but also abroad. The helical and straight spur specification No. 436, will be one of a series now being prepared for gearing and which will be of importance to production engineers throughout the country. The specification deals with the question of the dimensions in a more comprehensive manner than has hitherto been attempted. Machine cut gears connecting parallel shafts are dealt with, the teeth being either straight, single or double helical, and of the 20° full depth involute system. The following are the classes :—

Class A. Precision ground or cut gears suitable for peripheral speeds exceeding 2,000-ft. per min.

Class B. High class cut gears suitable for peripheral speeds between 750 and 3,000-ft. per min.

Class C. Commercial cut gears suitable for peripheral speeds below 1,200-ft. per min.

In addition to dealing with the form of gear teeth, clearance, maximum permissible pitch errors and tolerances, the specification lays down standard formulæ for the strength and rating or power transmission of gears and includes a series of charts showing, at a glance, the proportions for gear-wheels of different materials. The technics are rather involved and not being an expert in this line I will leave you gentlemen who are familiar with the specification to discuss it amongst yourselves.

A comprehensive series of standards has been prepared milling cutters and reamers, straight and flute drills, etc. One of the most valuable aspects of these specifications is the inclusion of full diagrams illustrating the nomenclature, which, for the manufacturer purchasing from specialised producers, must be invaluable.

It is of interest to know that included in this work, specifications have been prepared covering milling machine spindle noses and arbors and lathe centres. The 90° centre is as you know still being used although it has to a certain extent been displaced by the 75° angle and to a much greater extent by the 60° angle. In view, however, of the widespread use of the 75°, the committee decided to include both

the 60° and the 75° but they strongly recommend that the use of the 75° should be discouraged. It is said that the failures which have occurred with the use of the 60° angle are due generally to the working centres not being sufficiently large. Another interesting series of specifications just brought to completion are those dealing with the attachment of circular metal cutting saws and circular saws for woodworking.

In answering this particular question as to how far the production engineers are familiar with the work which is going on, I have left to the last the subject of fusion welding. Whilst the work is related principally to electric welding, gas welding has not been overlooked. Specifications are in course of preparation covering the application of fusion welding to all the principal classes of engineering construction. You can well imagine the difficulties which have been met with in attempting to obtain agreement on the form of test piece to be adopted for welds and weld metal, and a sub committee is actively engaged in drawing up a schedule of welding tests which can be readily applied in routine work. The form and nature of the test will of course depend upon the class of welding work which is being carried out.

One of the attendant problems of interest to the drawing office which arises as a result of the application of welding is the devising of a suitable system for indicating on engineering drawings the forms of welds and of welded joints to be used. The variations in the form of joint are numerous, so that any system used, to be of value, must be very elastic and capable of indicating clearly the exact details of the welded joint that has to be made, whilst the adoption of a uniform system is of prime importance for the easy interpretation of drawings. This is a matter therefore which is receiving the careful attention of the Welding Committee and before long it is hoped that a specification will be issued which will provide a complete and comprehensive British standard system. Standard definitions of welding terms will also be included.

The Standard Institution is also engaged in the very important questions of standards regulating the use of welding as a method of construction, and the B.S.S. for fusion welded air receivers which will be published in the near future will be the first nationally agreed specification relating to fusion welding construction to be published in this country. Amongst other aspects of welding which are being considered is its application to general constructional work and the preparation of B.S. specifications for both bare and covered electrodes is also in hand.

(3) What are the Fundamentals of Standardisation ?

On this subject one could obviously let oneself go for an hour or so, but don't be alarmed, I have no intention of doing so. I think,

however, it will be sufficient to state that if interference with design and progress, resulting in crystallisation and stagnation is to be prevented, it is absolutely fundamental that the committees carrying out the work should be standing committees, that there should be periodic review and revision, though, on the other hand, the specifications must have a certain permanency, otherwise they would be useless, and above all, that the community interests of the producer and the user should be maintained throughout.

Again, particular care must be exercised not to undertake standardisation unless absolutely assured that it is to fulfil a generally recognised want. Moreover, any proposal should be supported by some authority, such as a trade organisation, technical institution or a government department, and not merely put forward by some enthusiastic individual. There should also be a concensus of opinion of all those interested, favourable to the work being undertaken, before it is actually put in hand. Even then the proposals of any committee appointed to carry out the work should be subject to the widest possible criticism by the trade, constructive naturally. Finally, all standardisation should be arrived at by general consent of all parties concerned.

(4) Can Standardisation Assist the Production Engineer, and if so, what should be standardised ?

Standardisation, as far as I can see, should surely be of great assistance to the production engineer, particularly in those firms where the production engineer is closely co-operating with the design department. I suppose it would be generally agreed that the cost of tool maintenance could be very much minimised by a judicious system of standardisation.

Standardisation should assist the production engineer in advising on changes in design which if they are not to be too costly must surely be arrived at in consultation with the machine tool expert. It is for the latter to persuade the designer to look carefully over the standards before discarding them. Co-operation amongst production engineers would appear to be helpful in the advice they could collectively offer to the machine tool makers, so as to help toward the ease in changing dies quickly and at not too heavy a cost. There is also the question of jigs, to which the Americans and Germans seem to be giving much attention.

Then again, if we turn to the motor car industry for instance, there are certain components running through all cars, which would surely lend themselves extraordinarily well to standardisation, without seriously limiting design. That of course needs a spirit of co-operation, but one only has to think of the rods and the brake drums, and other wearing component parts, to see how immensely " service " would be simplified and expedited, particularly abroad if

there was a certain measure of interchangeability. When I was in Australia last year I went to one of the works making brake drums, where they had to keep 60 different sets of dies, in some cases differing only by about $\frac{1}{32}$-in.; perhaps that is not quite so bad as having to keep 125 different patterns for steel tyres to suit the railways and tramways of the six Australian States.

I agree very fully with the statement in the memorandum which I am following, that there is probably quite a wide field for internal works standardisation, though I am not quite sure whether it is so obvious that this latter only concerns individual firms. It certainly is well worthy of the fullest investigation. If your Institution were to set up, as many other institutions have done, a standards committee to explore the ground it is probable that you would find agreement among yourselves to request the B.S.I. to prepare standard specifications for a certain number of tools and equipment which would be found common to you all, or could be common to you all, without interference with your individual needs.

I see spindle noses are referred to but these have already been standardised as I have just mentioned. As to engineering catalogues this subject has several times been brought to our notice, but so far there does not seem to be a generally recognised desire for the standardisation of engineering catalogue sizes.

(5) Could we obtain closer co-operation towards standardisation than already exists ?

If, as I suggest, you will consider the appointment of a standardisation committee of your own, then in the interests of your members, you would be in a position to ask for representation on those committees of the B.S.I., the work of which is of direct concern to you and thus help by giving the members the concensus of opinion of the production engineers on the various problems under discussion. This would have so much more weight than the views of any single individual, however eminent.

(6) Is it possible to forecast the lines of action for the future of standardisation ?

Again I feel I must agree with the very wise statement in your memorandum that it is difficult to forecast that future.

Without in any way taking the position of the technocrat, it is quite obvious that mechanisation of industry will continuously progress. It would be foolish surely to attempt to put the clock back, as someone has suggested by limiting invention for ten years. The civilised world means to progress along these lines, and obviously from the ethical point of view we can only welcome such progress as easing the human burden. What we have obviously to do is not to limit invention or production, but rather to endeavour to bring

consumption more nearly equal to production. This is really a social question which, of course, I cannot enlarge on now even were I capable of doing so, though it is a question we must all have in mind as it is of vital interest to everyone of us.

A tremendous growth in co-operation and organisation in industry, is to be seen everywhere ; indeed it is this co-operation which is making standardisation possible and effective. It is for this reason that I am inclined to urge you to organise yourselves so that you can take a more effective part in it. The growing recognition of the value of this method of co-ordination is constantly bringing new requests to the B.S.I. for the preparation of British standard specifications. New industries are now taking part in the works such as the chemical and building trades and to a limited extent the textile. We have a very representative Timber Committee at work with the full co-operation of the Forest Products Bureau at Princes Risborough, and we also have a very comprehensive set of chemical specifications under way. There are some 600 committees, 5,000 members and about 1,000 meetings a year.

These nationally agreed specifications give a sense of security to the manufacturers because they put them all on the same basis and competition is fair. They give the purchaser a yardstick whereby he may compare tenders and at the same time obtain a recognised quality at a reasonable price, in fact they safeguard his buying.

Can there be any limit set to such a progressive movement. I do not think so, and so long as the safeguards I have mentioned are rigidly adhered to there need be no fear of over-standardisation.

Discussion, London Section.

MR. COOKE: You have given me rather a difficult task to follow Mr. le Maistre in dealing with questions of industrial standardisation, and the field which I am asked to cover is a little too wide to be dealt with briefly. There are, however, perhaps one or two minor technical points of particular interest to the production engineer to which I might call attention.

One important point is the question of screw-threads in relation to that of taps and dies. The limitations of the present screw-threads reports Nos. 92 and 84 are pretty well-known, and at the present time a revision is in hand in order to meet the shortcomings. It is proposed to introduce into these two specifications a clause to to provide for coarse fits. At the present time the British standard Whitworth thread specification provides for standard, and the British standard fine thread report for standard and close fits. During the revision consideration was given to the tolerances required for close fits, and an examination of these in conjunction with the tolerances required for taps and dies led the committee to the conclusion that the close tolerances specified in these reports had never been operative. The question of the standardisation of taps to produce screw-threads in accordance with these reports is receiving careful reconsideration by the committee and the work of the revision of the screw-threads specification has been held up until a decision has been reached in regard to taps and dies. I am sure everybody will appreciate the difficult nature of the subject when you realise the many variables that enter into any consideration of the design of taps and dies.

A further point to which I might draw attention has arisen in connection with the bolt and nut specifications. When the series of specifications dealing with bright and black bolts and nuts was published some time ago a specification was also issued dealing with spanners which was somewhat severely criticised. Mr. Dumas of the British Thomson Houston Co. in a paper recently before this Institution dealt at length with some of the objections to the specification. Perhaps the most serious criticisms were that the spanner tolerances were too fine and that the clearance between the largest nut and the smallest spanner were too small. The specification is now under revision, and tests have been made to determine the extent to which this clearance can be increased. It has also been decided that some indication should be given in the revised specification of the material from which the spanners are made. It has been contended in some quarters that one of the drawbacks to standard

spanners is that a fitter or mechanic has to carry a large number of spanners to fit the different sizes of bolts with which he has to deal. Whether this difficulty could be overcome by standardising adjustable spanners we do not know, but it is just that sort of advice which we want from your Institution and which your standardisation committee will be able to supply.

Mr. le Maistre has referred in his paper to the milling cutters and reamers specification. This specification contains much material which is not generally known at the present time, and the comments we receive lead us to think that perhaps we have tried to do too much in one specification. In it we have laid down standard dimensions for non-relief cutters of a variety of types, end and slot mills, key, key-way and gear cutters, and nearly thirty tables of reamers. A recent addition to the specification is the standards that have been laid down for milling machine spindle noses and for the accompanying arbors, together with particulars of standard adapters, so that old pattern arbors can be used with the new standard noses. The specification is as will be seen very comprehensive, but it may be that other types of tools ought to be included. A suggestion was made at the Leeds meeting that reamers with staggered teeth should be included, and we hope that with the co-operation of your Institution we shall be able to bring these specifications into something like suitable form.

The twist drills specification is of particular interest to production engineers and this specification includes a large number of types and sizes of drills. It is hoped to undertake a revision of the specification in the course of the next few months, and we hope that we shall secure the co-operation of your Institution to help us eliminate a few of the unnecessary types and sizes. In America a similar attempt is being made to revise and simplify their specifications.

Another interesting series of specifications are those for circular saws. We have, during the last two years, issued two specifications for circular saws—one for wood-cutting and one for metal-working, and a further specification dealing with metal-cutting saws for hot working will be published in the course of the next few weeks. Agreement has been reached in these specifications as to the method of fixing.

With regard to the specifications in the course of preparation. We have at the present time a fully representative committee that is dealing with the preparation of a specification for files in order to limit the number of types and sizes required to cover all requirements. The question of grinding wheels is also under consideration, and a specification covering all types and classes of grinding wheels commonly used in workshop practice is nearing completion.

MR. SALMON: There is one point which has struck me in regard

to the chart—is the purchases department an interested party in all the various committees? In this standardisation of reamers, drills, and files the purchases department should have some means of getting down to the shop's requirements. It has been my experience that you can lay out a specification for a bit of mild steel, we will say, quoted by Aircraft; the works are urgently requiring that steel, and the purchases department, knowing that the works are held up, may in their enthusiasm go round the corner to buy the first piece of steel they can get. The same might apply to any small tools urgently required in the shop—therefore, I ask the question—is the purchases department drawn in on this standardisation committee.

MR. LE MAISTRE: The British Standards Institution tries to get the purchases department represented whenever it can, but it has not always succeeded in doing so. We have actually had a chief engineer come in and agree to a specification, and then the commercial department of his own firm has continued to buy outside the specification.

A VISITOR: I am wondering if jigs and jig-parts and fixture-parts have been mentioned in that list. For some twenty years I have been lecturing up and down the country on standardisation, and particularly, perhaps, on jigs.

MR. LE MAISTRE: Jigs are not included at present. But there is an example of what I tried to point out in my paper—however eminent an individual may be, he is but an individual. Surely, here is an opportunity to bring before your standardisation committee the experience gained during years of lecturing. If the committee is with you, you have an opportunity of promoting the study of some useful proposals.

MR. COOK: There is, Mr. Chairman, a technical committee which is dealing with machine tool details, but the only committees dealing with machine tool details and accessories are those for cutters, end mills, reamers, lathe centres, files, grinding wheels, circular saws, and twist drills.

MR. FERGUSON (Member of Council): Whilst I appreciate Mr. le Maistre's remarks in connection with the co-operation of other organisations with the British Standards Institution, I should like some information as to what has been done by the British Standards Institution to interest the Board of Education, and educational establishments, in the work of the British Standards Institution, as in my opinion it is most important that the work of the British Standards Institution should be brought to the notice of boys who are intending to enter the engineering and allied industries, at the earliest possible moment. It appears to me that in order to assure that the engineering industry should obtain highly skilled craftsmen

well versed in the work of the British Standards Institution, their education must start when they are in the embryo stage.

In regard to the chart which is shown, I notice that under engineering technical committees there are shown two committees, one for dealing with pipe threads and flanges, and another for dealing with pipe flanges, but I cannot see any reference to a technical committee for dealing with components used in the heating and domestic engineering industry. This is quite an important section and I expect there are many here this evening who, like myself, have had difficulty in dealing with such components as Bibcocks and other domestic fittings, owing to the fact that they are not made to fit the standard sized spanners, and very frequently one has either to insert a packing piece or use a file to make a workable fit.

MR. LE MAISTRE : I am delighted to hear that first question, and it shows, at once how fruitful this meeting is likely to be. We have for a long time been trying to ascertain the best way of interesting the embryo engineer, in the British Standards specifications. It is one of the most important aspects of national standardisation. It is, however, the first time I have heard the Board of Education mentioned in this connection. We have tried to a certain extent to get some of the teachers' organisations interested, but without much success. Perhaps they are not the right organisations to use, but I and sure you production engineers will be able to help us get on the right lines.

The British Standards Institution undertakes standardisation when asked to do so by a responsible body. In this particular case there happens to be an Institution of Water Engineers which has done excellent work in regard to standardisation, but whilst they are inclined to co-operate with us, so far they have invited us to do very little in the field mentioned.

MR. PUCKEY : So much excellent work has been done on the subject of standardisation that one approaches with diffidence any criticism of the British Standards Institution. There are, however, one or two minor points I should like to put forward. In the first place I think that, whilst you have a most excellent organisation for making standards, you have a bad organisation for selling them. It is probably just as hard to sell a standard as it is a machine tool, but it is certainly equally important. I do really think that the selling organisation of the Institution could do with a certain amount of overhaul. Most of the pamphlets sent out to my firm come my way, and I must say that they are not very impressive documents. I think it would be an advantage if your booklets had a much brighter appearance than they have at the present time and, while I should not say that " the shirt around the pudding is the most important item," I do feel that these documents could be made much more attractive and at the same time preserve the most excellent technical

matter inside. Those of you who have any knowledge of Professor Perry's excellent books on Mechanics and Calculus will appreciate what I mean. These books, while treating on most abstruse subjects, are most readable and an adventure rather than an exercise, and if a little more of this human matter could be put into your specifications, and at the same time their dignity preserved, I think they would become much more popular.

My second point is: "Do you not think it advisable to have a few more meetings of your committees?" You mention figures of 600 committees and 1,000 meetings per year, that is, just over one-and-a-half meetings per committee per year. A lot can be done by correspondence, but my own experience is that there is nothing like the personal touch now and again to stimulate interest. I am supposed to be a member of one of the technical committees of the Standards Institution, but it is a very long time since I attended any meetings, and personally I do not feel that I am overworked in connection with the preparation of standards.

Your organisation has done most excellent work so far, but there is of course quite a lot of work yet to be done, and four points come to mind, that have had my attention during the past few weeks, that might be worthy of further discussion.

(1) Gauge of sheet metals.—There was rather an interesting article in *Machinery* a few weeks ago relating to this, and I do feel that, taking into account the considerable increase in sheet metal work during the past few years, which will I believe be continued, that some simplification of the existing standards should be attempted.

(2) Grinding wheel sizes.—I am very glad to note that something is being done regarding grinding wheel sizes, as a very large number of sizes at the present time appear to me to be redundant.

(3) Taps.—I am not concerned at the moment with the threads of taps, but I am referring particularly to the driving square at the end. You get a tap from one firm with a thin shank, and another one with a fat shank, and it thus requires a large number of adaptors to drive these taps if you get the taps from a number of firms, as is the usual custom.

(4) Standards of finish.—To be quite frank I would not like to be on the committee that has to decide this question but, although it is really a difficult one, I think that something will shortly have to be done in this direction. A colossal amount of work has been done in determining and standardising overall dimensions of cutters, reamers, etc., but very little work has been done on the details design of the parts in question, such as number of teeth, cutting angles, speeds, feeds, etc., and I feel that there is an opportunity for the Institution of Production Engineers to step in where the British Institution "Angel fears to tread."

Some months ago I wrote to the committee pointing out this fact and asking them if something could not be done, and I had a most peculiar reply to the effect that, as the subject matter would be out of date by the time it was in a form suitable for issuing to members, it would not be convenient to do any work in this connection. After recovering from this shock, in my reply I pointed out that, if this attitude were correct, all the proceedings of our Institution and all the technical papers published were obviously out of date, as some time must elapse before they are published; and, if our Institution were so inefficient as to require so much time that the subject matter would be out of date before publication, there must be something radically wrong with us. I do not think, however, that that is true, and I was going to protest most strongly to-night about that attitude on the part of the committee, but, as I heard some mention a short time ago of a standardisation committee that was set up last Saturday, I am going to presume that my letter has borne fruit.

There are two matters mentioned on this memorandum to which I should like to draw attention, these being the questions of drawings and of catalogue sizes. Regarding the question of drawings, I do feel that something should be done here to interest firms in adopting a standard method of projection. Having spent quite a number of years on the board—drawing I mean, not directors—I feel that much time is lost both by draughtsmen and the shop men in overcoming difficulties that would not exist if standards laid down were adhered to. At one place you have to lie on the left side and at one place on the right side and at another you stand on your head in order to get the proper projections and the amount of time wasted, as I have said, must be enormous. Catalogue size is a very sore point, and I am surprised that more has not been done in getting a more attractive and standard form of catalogue. I was very interested in Mr. Ferguson's remarks regarding the question of the Board of Education and the embryo engineer. We have all had experience of machine drawing text books, the same old parts such as pipe flanges, etc., absolutely unidentified with any current practice, and I think that if young engineers could be trained to appreciate the work of the British Standards Institution, a very considerable step forward would have been made towards the realisation of its aims.

Mr. le Maistre : I wish I could answer in the same happy vein in which the friendly criticisms have been advanced, but I have not that vein of humour which the gentleman from Croydon has. I like his criticisms, though I would have liked them in regard to specifications to have been a little more constructive and detailed.

We do want to make our specifications as attractive as possible and perhaps your Institution can help us to make them so. But you must remember that we have been going now for thirty years and we have already met and dealt with a good deal of criticism,

constructive and otherwise. We ask that your suggestions shall be as practical as possible. Some people have suggested that we ought to have advertisements in the specifications ; that brings up very many difficulties. We have now made arrangements, however, with the Engineering Drawing Office Manufacturers' Association, who have something like twenty different centres in the country, and instead of having to write to London for one of our catalogues, engineers can go straight to one of these shops and obtain what they want.

Directly your organisation becomes a member of our Institution, you become yourselves part of the British Standards Institution, and can suggest modifications from within.

I think the questions Mr. Puckey suggested are most excellent things for your members to take as a basis for critical consideration with a view to sending to the British Standards Institution your proposals.

MR. NORTHEY : I desire to say something on the remarks passed on education. I should like to congratulate the British Standards Institution on recognising that the production engineer is of value to the other bodies of engineers that have been looking into this matter. For some considerable number of years in the teaching profession there have been some of us putting in a good deal of spadework to bring certain members of the public to realise that the basis of industry, at least in my opinion, is the production engineer, and no amount of drawing up of standards by other bodies is going to get us a co-ordinated policy until we give the production engineer his place. Regarding standards and education, there are a very large number of educational institutions which are teaching their students British engineering standards, but our greatest difficulties lie in the fact that outside in industry those standards have not yet been adopted. Another difficulty, which is really a criticism, is the numbers, for instance, of limits and fits in engineering. Owing possibly to the unilateral and bilateral systems they are overwhelming in number, and I should like any member that can get a copy of the limits to go into them and see what you have to show a student in the way of fits and tolerances suggested by the Standards Institution.

In regard to the question of drawing office practice, there would be a lot more useful information available if we had a production engineer on the committee. They certainly give us the first angle and third angle projection and certain sketches and drawings and sizes of paper, but I am not altogether sure that the production engineer would agree that they are the best. In regard to getting in touch with teachers' organisations I think that the production engineers know that teachers' organisations are in a way looking at things from their point of view, but one has to remember that when

you come down to dealing with the educational side you are up against a very great problem of examinations. Your degrees and your national certificates examinations do not cater for the man who is going to be a production engineer. I should like to suggest that if possible all members should be sent a copy of that chart, which would be most useful. In my opinion by far the largest number of committees there should have production engineers on them. Whether it is from the point of view of refining or smelting, material, drawing, welding, or machine tool questions, etc., we undoubtedly need the production engineer on these important committees. The production engineer must make his voice heard and this Institution can do it if we like to put our backs into it.

MR. LE MAISTRE: I can only say that I agree with practically everything the speaker has said. So far as limits and tolerances are concerned, you must remember that that was carried out at a time when the idea of simplification was not at all in the forefront. My advice would be to look through a few of our specifications, see where you consider them out of date, where they are not practicable, make your suggestions for simplification, and you will be making a very substantial contribution to the saving of preventable waste. As to the educational side, I am extremely interested in the speaker's remarks.

MR. SALMON: I would like to refer to a remark on the adjustment of the specification on taps and dies made by our friend Mr. Cooke. I do not agree with the suggestion at this stage to interfere with taps and dies. Suppose we take B.A. threads, for example. These have been established for many years and are known all over the world. But any alteration will affect your interchangeability, and this question needs very serious consideration. With regard to the standard of colours I would like to refer to an industry which is growing around us very rapidly—bakelite. Bakelite powder is being made in all parts of the country by twenty or thirty manufacturers. You ask for samples of brown, shall we say, and you get differences of shades so minute that they can only be seen in daylight; here, a standard of colour is certainly going to be very, very useful to the bakelite industry. I would like to ask the speaker whether anything has been done in regard to bakelite and putting the whole thing on a standard basis.

MR. LE MAISTRE: There is, I think no suggestion that modifications will be introduced which will destroy interchangeability, but in dealing with the question of screw-threads tolerances have to be considered, and you cannot settle on satisfactory tolerances until you can get some decisions on the tools which will be used to cut those threads. Our Institution has not been asked to study bakelite and its various colours, though a standard system would doubtless be of considerable assistance. Mr. Chairman, may I say how

delighted I am with the discussion which has taken place. I hope it will not end here, and that my Institution will in due course receive some really constructive suggestions which I can assure you will be most acceptable. May I add a few words regarding the international situation. Standardisation in the international field, as you know, has been going on for several years. The electrical industry has been fortunate in that its basis is the same all over the world, being young and progressive.

Among the electricians of the world there has been a league of nations, which although smaller than its great sister The League of Nations, has nevertheless accomplished some most useful work. Meetings of this league, The International Electrotechnical Commission, have been held in many countries. A number of advisory committees are constantly in session preparing for the plenary meetings, the next of which will be held in 1934, in Czechoslovakia. The understanding of each other's difficulties and the co-operation which thereby results in so far as the International Electrotechnical Commission is concerned, has been most fruitful. Such international meetings do much towards promoting good feeling and the smoothing out of the difficulties in international trade.

One of the reasons for the success of the International Electrotechnical Commission is that the major portion of its work deals with the question of reception tests, and the performance and rating of machinery. It is really an endeavour to speak the same technical language and to provide an adequate basis for the comparison of tenders, so that when a man orders electrical machinery from any country in accordance with the International Electrotechnical Commission's rating or specification, he has some measure whereby he can compare tenders, and at the same time assure himself that the output of the machinery is what it claims to be. One of the most recent pieces of work of the International Electrotechnical Commission in regard to steam turbines has had the co-operation of the chief steam turbine designers of the world. In this our American friends have been of the utmost assistance.

In the mechanical field, the international aspect of standardisation has only recently been given serious attention. In 1926 in New York, the International Standards Association, the I.S.A. as it is called, came into being. It has its headquarters in Basle, and is a federation of the national standardising bodies. Our Institution, which was represented at the New York conference when it was formed, is not a member, as the mechanical industries of this country have not so far been prepared to co-operate internationally. In regard to mechanical components, the main object of international standards is directed towards interchangeability and that implies agreement on exact sizes. It is here that you come up against tremendous difficulties, quite irrespective of the difficulty of the

metric and English measures. I might perhaps refer to one subject as an example of these difficulties.

Under the aegis of the I.S.A. an international committee is considering the question of taper roller bearings, but unfortunately the procedure of the technical committees of that organisation is not similar to that generally adopted in this country where standardisation is arrived at by general consent of all parties concerned. They arrive at their decisions by simple vote, which in this case has meant voting down the standards of the largest maker in the world of these taper roller bearings. Such procedure, as I think you will agree, is not calculated to inspire confidence in the methods of the I.S.A. International recommendations arrived at in such a manner are bound to imply a certain sense of coercion and to raise many commercial difficulties.

On the other hand certain branches of industry in this country are anxious to obtain international agreement on tests and testing procedure, notably in the case of petroleum products and the sampling and analysis of coal and coke, and our Institution is giving these matters most careful consideration. You may rest assured that no step will be taken in the international field of standardisation which has not obtained the fullest support of the industries concerned. It may be that the work of the I.S.A. will eventually divide itself into two categories, which seem to be indicated, namely the co-ordination on metric dimensional standards on the continent, and real international agreement on tests and testing procedure in various directions.

THE CHAIRMAN : Well, I am sure we have had a very entertaining and instructive evening. I should like to call on Mr. Green to move a hearty vote of thanks to our lecturer.

MR. GREEN : Sir, it certainly is a pleasure to me to rise to propose a vote of thanks to you. I have had the opportunity this week of hearing Mr. Dumas lecture at Ipswich. From what I heard on that occasion and from what I have heard to-night I am convinced that this Institution is going to be a great help to the British Standards Institution which was formerly known as B.E.S.A. They are now doing an enormous work ; they have got a great deal of work to do when this Institution comes into close contact with them. The work of the purchasing agent has been mentioned to-night once or twice and I feel rather sorry for that crowd of people because I can see that they are not going to be required in the future. The production engineer will say, " I want so and so " ; it is a well known material at a well known price and the purchasing agent will unfortunately disappear to some extent. I am sure we have had an enjoyable lecture and that this organisation will have great success in the future. It is with great pleasure that I propose a vote of thanks to you, Sir.

MR. LE MAISTRE : Mr. President, on behalf of Mr. Cooke and

myself I thank you. I have enjoyed this evening tremendously, and I say that we are going to have the most friendly relations in the future and that you are going to be the most tremendous help—not to the Institution—you will be part of it, but to the engineering industry of this country.

Discussion, Yorkshire Section.

MR. J. GRATRIX, who presided, said that Mr. le Maistre had purposely left them plenty of time for the discussion of his paper. There were many important points to be considered and one that would interest production engineers was whether the British Standards Institution had done anything with regard to the standardisation of machine tools. He pointed out that it was a source of worry to the designer who had to design a firm's equipment to find the particular machine tools he needed all varying. What standard had been determined upon for spindle-noses? In relation to tolerances there was the question of bi-lateral or unilateral systems.

MR. LE MAISTRE: The question of the standardisation of the specific class of machine tools mentioned by the chairman has been discussed at various times. It is one of those points about which the desire of those closely interested has not been, shall I say, very articulately expressed. Not many people have brought it up and it certainly has not had the backing of any institution. It is just one of those things you production engineers, if you were to sit down in your various branches intent on thrashing them out, you will bring out quite a number of points. I was over Austin's works a month ago and whilst talking to a research man there I found there were quite a number of points in some of the modern machinery where standardisation of tools would certainly help matters—quickness of change and so forth—and lots of tool equipment which, if standardised would not interfere with design. With regard to the chairman's question as to the standard determined upon for spindle-noses, they have not yet been standardised. As regards tolerances, the position is extraordinarily interesting. A few years ago we had a tremendous battle over it. When you discuss bi-laterals with so many people you find they say there is no bi-lateral—by that you mean merely distributed.

MR. J. D. SCAIFE (Member of Council): The bi-lateral may be lateral also. In the case of the spindle, as usually understood, it is a tolerance on either side of the spindle—a nominal upwards or a nominal downwards. That is the distinction between the two systems.

MR. LE MAISTRE: In our discussions a few years ago the proposal was to adopt the unilateral system except for the motor car industry. In certain cases they cannot use the bi-lateral system, but four years ago the bi-lateral was certainly used in 70 per cent. proportion in the motor industry. What the position is now I do not know. We are going to wait another year and then we shall send round to see.

MR. SCAIFE : The subject of standardisation is one which is being discussed at all our branches and having been present at two of the meetings and having heard the subject treated in two entirely different ways, the thought has occurred to me that as an Institution we are entirely out of touch with what has already been done by the British Standards Institution. Mr. le Maistre has made this point clear and I shall take steps to bring before the Council the necessity of keeping in touch with what has been and is being done in the way of official standardisation and, as far as possible, being represented on the committee dealing with matters concerning productions. It would not be a bad idea to have a tabulated list of specifications approved by the Institution. Dealing with the actual specifications of details such as keys, spanners, taper pins, screws, etc., these have been fairly well standardised as regards dimensions, but not as regards materials which are, in many ways, just as important as dimensions. Coming under the heading of standardisation is the question of tolerances and whether these should be unilateral or bi-lateral. Many years ago when I first became acquainted with the question, I was of opinion that there was little or no difference in practice. I am not of that opinion to-day, and though the advantages of the unilateral system over the bi-lateral may not be worth the enormous cost of changing over, this might be an opportune time to have the question thrashed out by the Institution. No better means could be found than this Institution for thoroughly sifting the evidence for and against each system. As a separate sub-section of standardisation it is worthy of separate treatment by a paper of its own.

MR. LE MAISTRE : I am very interested in Mr. Scaife's remarks, particularly on the question of spanners which is causing so much difficulty, and which is a matter vital from the commercial point of view. When we started on the spanner question we either went too far or we did not go far enough. Mr. Taylor, of Leicester, is taking a very great interest in it. But there are two schools of thought. One thinks that only the larger spanners should be standardised ; others that the complete range of spanners be standardised. Mr. Scaife's comment is that we should really ask for the standardisation of materials. Spanners, of course, are sold by the hundred for the purposes of motor car manufacture. The spanner is what might be termed a piece of apparatus which when finished is even then much nearer the raw material than almost any other thing you touch. Consequently, from the economic point of view there is very little in the standardisation of spanners. If you could advise us as to the material, design, and dimensions it would be very helpful. I do not believe it is physically possible to do without either the unilateral or bi-lateral systems, unless it is that the prominence of methods of production is going to enable

us to do so. I remember Mr. Remington, of Wolseley's, and Mr. Thompson, protagonist of the unilateral system, went at it hammer and tongs in one debate on the subject. In the end it was felt that we ought to lean to the unilateral system and that in the aircraft work at any rate we ought to do without the bi-lateral. Whether it will be possible to have the unilateral system standardised as it is on the Continent with a few exceptions, or whether you will want the bi-lateral system, I do not know. America, as you will be aware, is bi-lateral much more than unilateral. These are problems which will come forward in our counsels again and be fought out with as much vigour as ever previously.

MR. SCAIFE: In regard to the motor car trade there will be always the difficulty of the ball bearing fits. These are a very important item to the motor industry. Those standards were fixed before there was any question of unilateral or bi-lateral systems, and it will be as difficult to alter them as it is the gauges of the railroads. That does not alter the question as to the better method, and because there are certain objections on that side, it does not mean to say we ought to go on for ever as we are.

THE CHAIRMAN: I do not think there is much prospect of the motor trade altering their outlook due to the capital outlay involved in a change. It will cost a tremendous lot of money in the motor trade to change over from the unilateral to the bi-lateral system. As regards ball race fits, in my own firm although I have introduced the unilateral system, I am compelled to make special gauges for ball race fits. The unilateral system will not do there.

MR. HILL said the problem of the unilateral versus the bi-lateral had not been talked about sufficiently to create a universal opinion either one way or the other. He would like to see the Institution of Production Engineers examine the problem more minutely in the future than they had done in the past.

MR. LE MAISTRE replied that the members of the Institution ought to get together and examine really carefully the standards that had already been arrived at, and they should be the people to see that those standards were put into operation. They had the vigour of a young institution and they ought to demand entry into the British Standards Institution and should see that the standardisation of tools, etc., went along the right lines. He (Mr. le Maistre) wanted the Institution of Production Engineers to come in and see that they did not perpetuate really bad habits. In drawing office matters it was the young men in the works and the young students who were to be managers later on, who ought to be taught the value of standardisation. It was by teaching the younger people, as well as the old school, of course, that they would get what they wanted. He added: We have agents all over the country, and it is of vital necessity not only to us but to you to get some proper

organisation going in your Institution whereby you can watch what we are doing and can give us the concensus of opinion on these matters of the production engineers. In this case you are the trader, and the specialised manufacturer is the producer of the tools. Together there is no doubt we could bring about a certain amount of improvement and economy.

MR. NEWELL, after expressing indebtedness to Mr. le Maistre for travelling so far on a wretched night to give them the benefit of his carefully thought-out paper, said: With regard to the standard colour scheme Mr. le Maistre explained, to my mind it seems to be an extraordinarily difficult matter to standardise colours, because the perception of different individuals must vary considerably. My view of the red, for instance, may differ from that of everyone else. Therefore I ask: What is the standard colour? With regard to the drawing office practice, I am quite familiar with the pamphlet Mr. le Maistre speaks of. As a matter of fact some years ago I was assessor for a certain outside authority on engineering processes, and it was my privilege to prepare examination papers of certain types. One such paper was for a machine-drawing test. I spent the greater part of a Sunday getting it out, and duly sent it along to the authority. Much to my consternation I was told that it did not conform to the pamphlet 308 which I had, then, never heard of. Naturally I examined this pamphlet, and I was very much annoyed to find that the only difference between my drawing and the specification was that my dimensions were in a horizontal plane instead of in a vertical plane. I had merely used the old-fashioned method. The result was that I had another three or four hours' work in doing it all over again. On the question of the welding test, I understand you to say that the British Standards Institution proposes to bring out standards from the point of view of testing. I am intrigued to see how the practical welders test these standards. The argument is that if it will stand 80 degrees of bend it is a good weld. As to the definitions of hardness and durability, I do not think your Institution has attempted to define what their conception of hardness should be. Most individuals determine this for themselves. There is no standard. If that was standardised, probably their method of testing could be standardised. On the question of standardisation I am in agreement with Mr. le Maistre, but I should like to raise a point which might strike many people. Is this standardisation altogether a benefit? From a production point of view it is practicable, but from everyday life is there not a danger of too much standardisation? In standardising everything, do you not think it is rather tending to get a standardised mind? With regard to the pamphlets you have issued—schemes of standardisation which may have been accepted throughout the country in production—what happens when someone thinks of an improvement on any standard scheme?

In reply to Mr. Newell, MR. LE MAISTRE said that on the question of colours the British Colour Council pointed out that if half-a-dozen firms were asked to supply a colour they would get many different shades. The question of the human factor was not completely eliminated by the colour filtration method they had suggested. Only one country in the British Empire was going to do it, for at the Ottawa Conference it was agreed to accept the British standard of colour scheme. The British Colour Council thought we should get a complete standard out as quickly as possible so that the Germans should not get one over us. On the question of the drawing office practice, he suggested that their Institution should take the report and recommend their members to adopt it. With regard to the welding test, it was extraordinarily difficult and they did not yet see daylight on it. In reply to Mr. Newell's question as to whether these standardisations were altogether a benefit, he saw the answer to that put rather well, he thought, in a report he had read which said : " Integrity should not be emasculated by inordinate self-interest." He was convinced from what he had seen that more and more in ordinary materials and machinery our exports would have to be on a co-operative basis. Whatever we said of Russia—and he spoke of personal knowledge as the result of a lengthy stay in Russia —they were pointing the way. Was standardisation tending towards a standardised mind ? If they went to America it certainly was, but that was a country which lent itself so well to standardisation. Still it was standardisation largely by individual firms. We had to keep the balance and prevent over-standardisation. There was room in this country for a great deal of standardisation up to a point—even in motor cars. At present there was no co-operation in the motor industry. Mr. le Maistre added : I do not think in this country we shall ever come to the standardised mind.

MR. NEWELL : Perhaps it is too early yet to judge.

MR. LE MAISTRE : Lastly, Mr. Newell raised a most important and a most difficult question. Some means have got to be found so that these improvements when they do come along shall not be squashed by the trade organisation that wants to sit down and say : " We have got this and we are going to shut everybody out." It is a matter which will have to be given grave thought or otherwise standardisation may create great disadvantages.

MR. KLOW and MR. BENTLEY having taken part in further discussion, MR. SCAIFE suggested that the Institution of Production Engineers should take a definite stand. It seemed to him that they ought to be represented on the various standardisation committees. It had an important bearing on economics.

MR. LE MAISTRE agreed and suggested that they should appoint two representatives.

THE CHAIRMAN remarked that only the fringe of the subject had been touched upon in that discussion, and if Mr. le Maistre were to deal fully with all the phases of the question they would have to be there for a month. Personally, he (the Chairman) had no idea before that night of the amount of work these gentlemen on the British Standards Institution had tackled so far. It was tremendous, but they had much more to do yet, and he agreed that the Institution of Production Engineers should co-operate to the best of their ability. He suggested that every branch should form a sub-committee to deal with the matter.

After a vote of thanks had been accorded to Mr. le Maistre, to which he suitably replied, a resolution was passed at the instance of Mr. Hill, seconded by Mr. Newell, that the Yorkshire Section should, at the next meeting of the Council, urge the Council to take a more active part in assisting the British Standards Institution in their work.

STANDARDISATION AS APPLIED TO PRODUCTION ENGINEERING.

Paper presented to the Institution, Eastern Counties and Birmingham Sections, by R. Dumas.

Standardisation.

IN dealing with the question of standariastion it seems desirable in the first instance to make a list of the various kinds of standardisation which are involved looking at the subject from an engineer's standpoint, as clearly, if too comprehensive a list is attempted, it will become impracticably large.

The following schedule gives the main branches into which standardisation can be reasonably divided :

(*a*) *Dimensional standardisation.*
(*b*) *Form standardisation.*
(*c*) *Standardisation of nomenclature, definitions, and symbols.*
(*d*) *Standardisation of conventions.*
(*e*) *Production tools and accessories.*
(*f*) *Component standardisation.*
(*g*) *Materials.*

It is difficult to draw a dividing line between each of these sub-divisions, but nevertheless it will be found on examination that the above divisions cover the ground adequately.

Taking the first division, dimensional standardisation, a number of sub-headings are involved :

Dimensional Standardisation.

Length.
Area.
Volume.
Sub-division of measurements.
Preferred sizes.
Wire gauges :
  S.W.G.
  B.W.G.
  Zinc.
  Stub steel wire gauge.
  B. and S.
Size tolerances.
Unilateral and bi-lateral systems of tolerances.

Ipswich, 7th March : Birmingham, 15th March, 1933.

It will be clear that in this section alone, there is sufficient material for a number of lectures or papers. I propose, therefore, to deal with the various points somewhat briefly, particularly as there was a very admirable paper entitled " Gauging and Measuring Methods," by Mr. W. H. Carter, one of your members, read before the Luton, Bedford and District Section, in January, 1930, which deals with some of the phases of fundamental standards in a very able manner.

As mentioned in this paper, and as is well-known, the standard of length in this country is a metal bar 38-ins. long × 1-in. square in which are drilled two holes in which gold plugs are inserted in such a way that the surface of the plug is approximately co-axial with the bar. Lines are drawn on these gold plugs which give the length of the yard. The length is correct at a temperature of 62°F. and up till the beginning of 1932, all gauges sent to the N.P.L. for checking were checked at the same temperature of 62°F. With a view, however, of arriving at an International Standard Temperature for the checking of gauges, the temperature was, from the 1st January, 1932, changed to 68°F. or 20°C. This temperature had been previously in use in America and Germany, while in France, the highly inconvenient temperature of 0°C. was in use. It is obviously a matter of convenience that the temperature for checking gauges should be about normal room temperature as this involves less chances of error and also makes it unnecessary to make calculated adjustments of the dimensions to appear on drawings in order to obtain the kind of fit required.

The importance of adopting about normal room temperature for standardisation may be judged from the fact that a difference of 20°C. makes a difference of .0022 in 5-ins. for aluminium. This dimension is quite a material one when fits are being dealt with. It is very generally felt that it is not satisfactory to have a standard of length derived from a metal bar of the kind described above, as slow changes may be taking place in the actual length, and further, if by accident the standard were destroyed, it would be extremely difficult to reproduce another bar which could be guaranteed to be of precisely the same length. It is true that there are other copies of the bar in existence so that the risks in this direction are small, but there is also the risk that the various copies of the bar may be altering their length at varying rates.

The general trend of thought now is that the length of the basic standard dimension should be expressed in the number of wave lengths of the red ray of cadmium. It is probable that in the not distant future legal sanction will be given to this method of expressing the length of the standard yard and it is probable that at the same time steps will be taken to so fix up the relative length of the metre and yard that the relation between the inch and millimetre will be fixed at 25.4 mm. exactly. International work is proceeding with

this as an objective. This figure is the one always assumed in engineering work when the question of pitches of screw threads arises and a change wheel of 127 teeth enables the two systems to be inter-connected.

In regard to the use of wave length of light as the ultimate standard of length, it is of interest to note that the apparent velocity of light has been going down in recent years and the question arises as to whether this is due to an actual decrease or whether it is due to more accurate methods being used for its determination. It is the general view that the latter explanation is the correct one. At any rate, as far as the metre is concerned it is known that no change has been detected in the relationship of its length and its equivalent in number of wave lengths of the red radiation of cadmium during the past forty years. Therefore, from the point of view of the most precise measurements of length, the apparent change in the velocity of light has no effect on the relationship between the wave length of light and the material standards of length. This phase of the question is perhaps somewhat academic from the point of view of the production engineer, but it is of interest to know just how the question stands at the present time.

Reverting to the temperature at which gauges are to be checked in future, there are no doubt cases where action will have to be taken. Ball bearing manufacturers, for example, are in process of changing over to the new standard which represents a difference of 0.00004-in. per inch. It will be seen, therefore, that in a length of 10-ins. a difference of four-tenths is involved. For many purposes this is, of course, immaterial, but where very precise fits are required this dimension represents a not inconsiderable proportion of the tolerance which would be allocated to this dimension.

It is clear that this is a subject which merits careful consideration and the adoption of a policy which will ultimately bring all manufacturing strictly into line with the new standard temperature of comparison.

All new gauges purchased, should, so far as possible, be on the basis of the new standard temperature. If this policy is adopted, the problem will automatically solve itself for the smaller dimensions, but where large sizes are involved some special steps may have to be taken. This would be particularly necessary where two concerns are making parts which have to mate.

It may be remembered that in 1920 the N.P.L. advised the engineering industry that the length previously taken as 1-in. was found to be 0.0000012-in. short, and that subsequent to that date checking of gauges would be on the corrected basis. The new temperature for checking gauges makes a difference of 0.0000037-in. in the other direction so that gauges are now checked on a basis

which would show them to be 0.0000025-in. longer per inch of length than the basis in use up to 1920.

The Binary System.

Although the legal standard of length is a yard, the dimension with which production engineers are mainly concerned is the inch, and the normal division of the inch is on the Binary system. The Binary system is a natural and instinctive one and gives a very suitable range of sizes for ordinary engineering work, but it certainly has defects which will be referred to when dealing with the question of size tolerances. One of the advantages of the Binary system is that it makes it easy to construct a list of preferred sizes and this is a point which does not often get the consideration to which it is entitled. It is obvious that each additional size which draughtsmen are authorised to use in the making up of their drawings involves a good deal of extra equipment in the factory in the way of drills, reamers, gauges, mandrills, etc., and it is consequently of importance to keep the number of sizes which may be used as small as possible, of course taking into account the necessity for avoiding waste of material. It by no means follows that a list of preferred sizes which is appropriate to one factory will be appropriate to all. For example, if in one particular factory a large number of shafts are required in which there are several shoulders, if too large steps are made in the list of preferred sizes and the smallest size of the shaft has to be kept to a prescribed minimum, then the largest diameter of the shaft may be unnecessarily large and result in waste of material so that in such a case it will pay to have small steps in the preferred size. Generally speaking, it may be said that where small quantities are being dealt with, the steps in the list of preferred sizes may be larger than where mass production is involved. In the former case the cost of the shop equipment in loose tools will be kept down to a reasonable figure,and in the latter case it is more important to conserve material, but whatever the nature of the establishment, it is suggested that there ought to be a list of preferred sizes in existence for the guidance of designers and the use of the manufacturing department.

Size Tolerances.

Another direction in which standardisation is useful is that of size tolerances.

This matter was very carefully considered by the B.S.I. a few years ago and B.S.S.164 was published dealing with limits and fits for engineering. This gives a useful series of limits which are applicable to the bulk of engineering work, although I would not suggest that the whole field is covered. It may be found necessary to interpolate other fits between those given in the tables to cover all requirements, but even in this case I have found the tables to form a very useful guide and to be of material assistance in keeping the practice consistent over

a considerable range of work. Unfortunately, at the time this specification was issued, it was not possible to agree definitely on whether the basis of the scheme of limits should be unilateral or bi-lateral, so both were included with a recommenation that for all new work the unilateral basis should be adopted. As is well known, in the unilateral system with the hole as basis, the low limit of the hole is taken as standard throughout, while in the bi-lateral system the hole tolerances extend each side of the nominal line. It may be mentioned that 13 or 14 countries are now standardised on the basis of the unilateral system, and I am not aware of any country other than this which has as standard a bi-lateral system, although I would hesitate to say that there is no such case.

In regard to the question hole and shaft basis, the general conconclusion seems to be that there is a need for both, and the latest I.S.A. proposals are on these lines. Even where both systems are legislated for, the anticipation is that the hole basis will be more used than the shaft basis. This is a question again where each individual establishment has to make its own decision with a view of keeping down to a minimum the amount of small tool equipment required for the execution of the work, paying due regard also to economy of material.

In regard to tolerances, there seems to be a universal concensus of opinion that a thousandth of an inch is a very convenient unit in which to express the latitude permitted, although with the finer work it is necessary to go to tenths of a thousandth and the tolerances in this case are conveniently spoken of as being so many tenths. This language is well understood in the workshop and I have known cases where metric dimensions were being used where the tolerances were always spoken of in this way. I believe it is a fact that the American standard list of ball bearings, which is in millimetres, has tolerances expressed on the inch basis. In metric countries the unit of tolerance is 0.001 mm. the symbol being u. This is a very small unit, its value expressed in inches being 0.0004-in. For ordinary engineering work this unit seems to be unnecessarily small.

It is evident that tolerances in thousandths of an inch do not accommodate themselves very nicely to dimensions expressed in the Binary system and it is almost universal practice where dimensions have to be controlled within smallish limits to express the dimensions in decimals. This matter will be referred to later under the heading of Drawing Office Practice which is in the conventional standardisation group.

A number of firms have adopted the decimal system of expressing measurements throughout. If this is done, the need of an approved list of preferred sizes is self-evident, as without this, a very large number of different dimensions are apt to be called for. One point which has to be kept in mind also is that so far as screwed work is

concerned, the existing basis of standardisation is on fractional dimensions.

I would particularly call your attention to the diagrams on page 21 of B.S.S.164 as being a convenient and informative method of selecting the limits to give a desired type of fit, and I would also like to endorse the recommendation made in Mr. Martin's paper on "Engineering Design and Drawing," read before this Institution in April, 1931, that standard fit charts should be prepared by each firm for the use of drawing offices, production engineers, and the shops, so as to embody experience on past work and to be a guide for the future.

Wire Gauges.

Another form of dimensional standardisation is that of wire gauges.

There certainly does not appear to be any justification for the continued existence of the standard wire gauge and the Birmingham wire gauge, and it would probably be difficult to secure the abandonment of either.

The ordinary form of wire gauge which consists of gaps in the edge of a plate is well known, but what is not well known is as to what a customer is entitled to expect from the supplier when he orders up some wire or sheet to a specific wire gauge number.

Some years back inquiries were circulated throughout firms in the engineering industry to ascertain what their practice was in inspecting material ordered up to a certain wire gauge number, and an astonishing variety of answers was received. In some cases the material was accepted provided it was accepted by the gap of the prescribed gauge number and rejected by the gap for the next smaller gauge number. In other cases sheets were accepted provided they were within $+7\frac{1}{2}$ per cent. of the nominal dimension. This obviously involves the use of measuring instruments other than the ordinary gap wire gauge. In many cases where + tolerances were adopted, very much smaller limits were imposed than those given by the $+7\frac{1}{2}$ per cent.

In the case of copper wire as used for electrical purposes, it has been found necessary to interpolate additional sizes and in the tables dealing with the matter the decimal dimension only is given with no reference to a gauge number and a range of tolerances for the various diameters is specified, varying from +2.8 per cent. for a wire 0.0032-in. in diameter to +0.1 per cent. for wires of 0.01-in. and over.

In view of the varying practice it is obviously essential for production engineers to see that so far as their own establishment is concerned, there is no dubiety as to what is expected from the suppliers of the material, as particularly where drawing operations

are involved, a great deal of trouble can be caused by sheets varying too much from the desired thickness.

In electrical work where large numbers of sheets are assembled together, difficulties are not infrequently caused by variation of thicknesses in the individual sheet.

There is thus need for the imposing of a smaller limit of variation in the individual sheet than over a range of sheets. Probably this phase of things is a little bit out of the range of general standardisation and comes down to a matter where firms dealing in a particular kind of product must in effect form their own standards on a basis which will ensure satisfactory results being obtained.

I do not propose to devote any time to dealing with standardisation of area or volume. The area standards are of course derived from the length standards and a unit suitable for the particular problem in hand is chosen; generally for engineering problems either the square inch or square foot. Also as regards volume. Here the cubic inch is, from the engineering point of view, the most useful unit, as it is the one used in nearly all cases for calculating weights, most people concerned in such calculations having at their fingers' ends the weight of a cubic inch of the various materials involved.

One of the points in which the metric system is supposed to have a definite advantage over the English system is in the inter-relation between weights and measures, the kilogram being the weight of a litre of water. The only difference which this makes is that in the Metric system the specific gravities of different metals have to be memorised whereas with the English system the weight of the cubic inch is memorised.

Form Standardisation.

	B.S.S.
Screw threads:	
Whitworth.	
Sellars.	
Briggs pipe.	
S.I.	
B.A.	
Lowenherz.	
Swiss.	
C.E.I.	
Acme.	
Square.	
Gear teeth:	
20° *involute*	436
14-1/2° *involute*	
Lathe centre angles	426
Tee slots	122

Milling machine spindle noses	122
Morse tapers	
B. and S. tapers	122
Railway tyres	276
Rim shapes for pneumatic tyres	5013

Screw Threads.

The dividing line between form standardisation and standardisation of details is often a little bit thin but I think it will be agreed that the above list is a useful one and it is quite probable that in addition to this general standardisation, individual firms will find it to their advantage to standardise other details in their work from a form standpoint. For example, the manufacturers of motor car engines may quite reasonably standardize the contour of cams for operating the valves so that the same former can be used for different sizes of engines.

In regard to forms of screw threads it is clear that there is an undesirably large number and it would certainly be beneficial if steps could be taken to eliminate some of them, particularly as the question of allocating working tolerances to screw threads is a complex one and consequently it is in the highest degree improbable that trouble will be taken to elaborate the tables required for all the different types listed above.

The Whitworth thread still holds its ground and less is heard nowadays of the difficulties associated with producing accurate form, a good deal due to progress which has been made in the art of measurement and projection and a good deal due to the availability of grinding as a method of production for taps and dies.

Production engineers can certainly bring their influence to bear on confining the thread forms in the establishment with which they are connected to a minimum and it is suggested that the Whitworth thread is the one that should be selected. The angle of this thread is quite firm enough, as the correction factor on effective diameter to compensate for a given pitch error with a 55° angle is 1.92. The factor for the 60° angle of thread is 1.73 and for the 47-1/2° angle of thread used in the BA system 2.27.

Gear Teeth.

In regard to gear teeth, a recent specification No. 436, has recommended the standardisation of the 20° involute tooth as being generally the most satisfactory form of tooth. This recommendation was made in spite of the knowledge that the 14-1/2° involute tooth is very largely used but there is no doubt that efforts should be made to work in the direction of using the 20° angle tooth almost universally and this is a direction in which the influence of the production engineers can be usefully exerted.

So far a specification has only been issued for helical and straight spur gears, but specifications for other types of gear are in preparation.

Lathe Centre Angles.

A B.S.I. committee, for which I was chairman, dealt with lathe centre angles some time ago and two angles of 60° and 75° were standardised. A questionnaire was circulated throughout the engineering industry when this matter was under review and it was found that while 60° was the angle in most common use, quite a variety of other angles were used to some extent. Some of the really old fashioned shops and some of the shops in which very heavy work was done still adhered to the 90° angle. A variety of angles intermediate between 90° and 60° also turned up and it seemed impossible to change over immediately to one angle of 60°, which in my view is what should ultimately be done. The determining factor in choosing 75° as being the second angle to be standardised was that the railway companies had chosen this angle and they, of course, handle a great deal of work in the way of axles which, generally speaking, are rough turned at the steelmakers' works. It is therefore important that the lathe angle is standardised so that rough turned axles can be dealt with without recentring after reaching the railway workshops.

Certain engineers were of opinion that the 90° angle was preferable for heavy work and suggested that trouble had arisen when 60° angle centres had been used. The view of the committee dealing with the matter was that the trouble was in all probability due to the 60° angle work centre not having been made deep enough. The diameter of the outer end of the centre hole in the work should be the same whether a 90° or a 60° angle centre is used. Unfortunately it was not possible to completely define the shape of the centre, as at present there is no common practice in regard to the shape of the taper hole in the back centre, but it is hoped to deal with this point at a later date.

Production engineers are in an excellent position to give a lead as to the taper which should be adopted for the tail stock end.

Tee Slots.

It is obviously a convenience to have tee slots standardised and it is not at all improbable that many here are not aware that this has been done. The standardized slots, however, are given in B.S.S. 122, and the appropriate cutters are also defined. Tee slots are not much used in the apparatus manufactured but they are often required in jigs and fixtures. It is obviously convenient to use the same sizes of tee slots as are employed in the tables of machine tools.

Milling Machine Spindle Noses, Morse and Brown & Sharpe Tapers.

There seems to be a decided disposition to get away from the slow taper used in the Brown & Sharpe list, and a certain amount of standardisation has been done in B.S.S. 122 which is really a copy of some of the latest American developments. The American Society of Mechanical Engineers has had the question of tapers under review for some years past and has circulated questionnaires throughout the industry in America to ascertain the views of the users. The proposals were shaping in the direction of adopting the Morse taper for the smaller sizes, and of using a steeper taper of .750-ins. per foot for the larger sizes. Consideration of this proposal has for the time being dropped due to the introduction of the new system of machine tapers proposed by the Brown & Sharpe company where a steep taper of 3-$\frac{1}{2}$-ins. per foot (which is the same as that used on the new noses for milling machines) in conjunction with a locking device is proposed. Just what will ultimately happen on this question of tapers is at the moment uncertain, but it is clearly a question in which production engineers are vitally interested as the importance of interchangeability of mandrills and cutting tools is very great.

A similar questionnaire to the American one was circulated in this country, and the result was a strong vote for the retention of the Morse taper.

As is generally known the taper of Morse sockets, while intended to be uniform, is not actually so. The variation is from 0.598 per foot for a No. 1 socket to 0.631 for No. 5. In the Brown & Sharpe tapers there is also a discrepancy, for while the taper per foot is supposed to be uniformly 0.5-in. it is 0.516-in. in No. 10. It is to be hoped that if any re-standardisation of tapers takes place, similar errors to these will not be repeated.

It would certainly be of interest to get an expression of opinion from the members of this Institution as to the line which should be taken on this taper question in the future.

Railway Tyres and Rim Shapes for Pneumatic Tyres.

These are two items where standardisation is obviously of very great service. So far as railway tyres are concerned, it assists the suppliers of the companies as they are able to use one standard set of tools for all the railways. Also a uniform standard of safety results. The standardisation of rim shapes for pneumatic tyres is an obvious necessity.

Nomenclature, Definitions, and Symbols.

	B.S.S.
Aeronautical terms	185
Telegraphs and telephones	204
Electrical engineering...	205
Photometry and illumination	233
Electrotechnique	423
Gearing	436
Keys and keyways ... ... *Pts.* 1 *and* 2	46
Small tools	122
Automobile and cycle parts	5012

The above list is not in any sense comprehensive as there are definitions included in some of the specifications dealing with component parts. The desirability of there being uniformity in nomenclature and of a definition meaning a specific thing is apparent. At the present time one finds that a certain article is known by one name in one section of the country and by another name in another section. It is necessary that we should all speak the same language so as to facilitate communication and understanding, and it may be useful to the members of this Institution to know that a fair amount of work has already been done in this direction.

Standardisation of Conventions.

	B.S.S.
Drawing office practice	308
Marking and colouring of patterns ...	467
Identifying colours for gas cylinders and pipes	349, 457 *and* 3011
Direction of movement of handles of machines and relative motion of slides.	
Opening and closing of valves and cocks.	
Location of controls on motor cars.	

It is clear that all the items covered by the above headings are matters of convention. In quite a number of cases there is practically nothing which can be said to justify the adoption of one convention as against another, although as will be appreciated by the members of this Institution, it does not at all follow that arguments cannot be put forward and debated for hours on end as to why one particular method should be preferred to another. It is in fact indeterminate questions of this kind which lend themselves to an indefinite extension of argument, since at the end of the discussion each individual taking part therein will have precisely the same opinions as he had when the discussion started. In point of fact, however, the only really important thing is to agree on a convention which should be universally adopted. Those of you who have driven motor cars in which the position of the brake and

accelerator pedals have been interchanged, will probably need no argument to convince you of the importance of standardising their position.

Drawing Office Practice.

The standardisation of drawing office practice is probably the most important item in the above list so far as production engineers are concerned, and it is greatly to be hoped that the recommendations embodied in B.S.S. 308 will be adhered to as closely as possible.

One of the main items is as to whether first or third angle projection should be preferred. The British Standard method is first angle projection, and this is quite sufficient to settle the question so far as I am concerned as all the arguments for and against first and third angle projection leave me entirely cold.

Methods of indicating threads are given in this same specification and of defining tapers which appear to be reasonable and should be adopted. Abbreviations are also given for a larger number of items which have to appear on drawings, and these are worthy of general adoption.

A very important point is the way in which dimensions and tolerances are expressed. It is axiomatic that it would be a great convenience to everybody if a uniform system were adopted. In this case I have a very decided preference for a specific method which is to always put the significant dimension as the one giving the maximum metal. This means that in the case of external dimensions the significant figure gives the largest article that will be passed, and the tolerances on such external dimensions are always minus. Conversely, in the case of internal dimensions the significant figure appearing is the smallest hole that will be passed, and the tolerance is always a + figure. For example, a shaft may have a maximum diameter of 2.502 with a minus tolerance of 0.002. In the case of a hole with the same limiting dimensions, the sizes will be given as 2.500 with a + tolerance of 0.002.

Where limit gauging by fixed gauges is in operation, it is perfectly clear that irrespective of the method used for giving the limiting dimensions on the drawing, the gauges will be made exactly the same and so far as the workman is concerned he has a " go " and a " no go " gauge, and he is obiously going to be satisfied so soon as the " go " gauge passes, and he will be entirely unaffected by the method adopted for showing the dimension on the drawing, so that the reason which is some times put forward for giving a + tolerance to dimensions, namely, that the workman will aim at the mean, does not find any sort of expression in the shop, as the workman will inevitably and justifiably work on the safety first principle.

Where measurements are carried out on production work by micrometer, it is obviously possible for the workman to aim

definitely at the middle figure, but a somewhat extended experience convinces me that even in this case the safety first instinct is likely to influence the workman to endeavour to keep the size of the article being worked on towards the high limit.

There are two outstanding advantages of the method I advocate of expressing limiting dimensions. The first is that the significant figure is the one to which the adjustable measuring instrument, if used, will be set, and the tolerance being given as a separate figure the workman sees immediately the order of accuracy required from him.

If I were to be debarred from using this method, my next choice would be for giving both the high and the low limiting dimensions in full.

I can imagine the members of this Institution having a good deal of power to further the adoption of uniformity in this matter and I suggest it would be helpful if there were a definite agreement on the part of the members as to the system they will advocate.

Marking and Colouring of Patterns.

I was chairman of the B.S.I. committee which dealt with this subject, which in the beginning was started by a recommendation arriving from Australia that standardisation should be effected. Obviously this is a case where little importance attaches to international standardisation and the basis on which decisions were arrived at was to interfere as little as possible with current practice. Also, to keep the scheme reasonably simple. The results are given in B.S.S. 467.

This is a matter in which production engineers are interested and I would again here express the hope that the recommendation in the B.S.S. may be universally adopted.

Identifying Colours of Gas Cylinders and Pipes.

This is clearly a matter of convenience and the subject has not yet been thoroughly dealt with.

It is suggested that this is a case where the members of this Institution should acquaint themselves with what has been done and come to a conclusion whether the subject should be more broadly dealt with.

Direction of Movement of Handles of Machines and Relative Motions of Slides.

This is clearly a subject in which production engineers are quite vitally interested and there is no real reason why standardisation should not be effected. It is obvious that it would be a great convenience to workmen to have all machines constructed on the same basis in this respect as it is highly probable that a fair amount of material is scrapped in the course of a year due to a lack of uniformity.

Opening and Closing of Valves and Cocks.

It is clear that this is also a case where standardisation is required so that the correct action will on emergency be instinctively taken. It is not going too far to say that a man's life may at times be dependent upon prompt and correct action.

Location of Controls on Motor Cars.

This matter has already been dealt with in the introductory remarks in this section and does not require further emphasis.

This list does not pretend to be at all a comprehensive one and no doubt members here will be able to add to it.

Production Tools and Accessories.

	B.S.S.
Milling cutters.	
Reamers.	
Rose bits.	
Tool shanks	122
Taper sockets.	
Arbors and adaptors.	
Milling machine noses.	
Tee slot cutters.	
Spanners	192
Saw drives	387, 411
Belting	351, 424
Drills	328
Files.	
Taps	
Dies.	
Jig bushes.	
Work clamps.	
Clamp supports.	

Bolts for Tee Slots.

This is a section in which production engineers will probably be more interested than in any other. It is certainly a matter of supreme importance to them that a reasonable range of small tools is available and that they should be standardised so that they will fit into the existing machines and will be immediately available for any purpose.

The various B.S. specifications quoted in the above list should certainly all be in the hands of production engineers so that they may know what is available and also so that they may state whether in their view other ground should be broken. It may be, for example, that they would wish to have other types of tools covered in B.S.S. 122.

There are some interesting points which arise in connection with some of the above specifications. Take B.S.S. 192 for spanners, for example. Although this was issued some years ago, very little use has been made of it, partly due to the lack of interest of users. The failure of the specification is not, however, entirely attributable to this cause. The specification has not been supported by manufacturers due to two reasons. First, the tolerances are unduly small, which makes the manufacturing problem unduly difficult for an article of this kind. Secondly, the various makers like to have variations in the pattern so that a spanner can be readily recognised as of their make. Apart from the smaller tolerances, the allowance between the largest nut and the smallest spanner is decidedly less than it need be so that the spanner is not too attractive from the users' point of view.

In making this statement, the fact that the B.S.F. size of nut is coming into fairly general use and that this makes good fitting spanners a desideratum is not being forgotten. The comparative failure of this specification has its lessons for all of us. Unless a specification takes into account all the factors involved and arrives at a really practical solution, it will be ignored by those concerned. The specification is now under revision and a number of experiments have been made with a view of determining the extent to which the allowance can be increased and concurrently more reasonable manufacturing tolerances will be specified.

It is to be hoped that as and when this specification is re-issued, it will come into more general use.

Saw Drives.

In regard to saw drives, an agreement has been arrived at between the makers of the saws, the makers of the machine tools and users, as to the method of fixing. Specifications have already been issued for woodworking saws and cold saws. One will come out shortly for hot saws.

Drills.

In regard to drills, a performance test is included in the specification. This was done at the earnest request of the government departments represented on the committee, who said that they would be obliged in any case to specify a performance test and that provided this were included in the B.S.S. they could work to it instead of having one of their own.

The trouble about including such a test in a standard specification is that progress is being continually made in the art and consequently a test which is alright to-day may be quite inappropriate in a few months' time. Further, these tests will probably have to be on a rather low plane so as to secure the agreement of the majority of

the manufacturers represented on the committee. In my view, specifications for such articles as drills should be limited to giving the physical dimensions of the drills and the tolerances to which they are to be made leaving the question of performance alone.

Files.

It is probable that a B.S.S. will be issued in the not distant future dealing with files, as a good deal of work has already been accomplished with ths end in view. One objective in making a specification for files has been very considerably to reduce the number of sizes of files required to cover all requirements. Such a reduction has been made and it is considered that the users will find their requirements are adequately met by the new list and naturally the manufacturers' problem is simplified.

In this specification again, the question of tests has been discussed and it may be said that there have been considerable differences of opinion as to the utility of tests made on machines, some holding the view that the results obtained from a machine are not a reliable index as to what is to be expected when the same file is used manually. Others, again, state quite definitely that since they insisted on a performance test, the quality of the files supplied to them has improved greatly. Some good is certain to come out of this discussion as a sub-committee is sitting in association with the University in Sheffield to endeavour to make testing conditions which will be recognised by makers and users as fair and as giving a reliable index to the quality of the file.

Taps and Dies.

A sub-committee of the B.S.I. is at the present time engaged in formulating tolerances for taps and dies. The subject is by no means an easy one, particularly as these tolerances are supposed to line up with the tolerances for screwed work in the B.S.I. tables. In making a schedule of tolerances for taps, it is clearly necessary to make specific allowances for pitch and angle errors, also for a tolerance on simple effective diameter. When an attempt is made to do this for standard and coarse fit threads, where it is reasonable to assume that cut taps will meet the requirements, difficulties are encountered with the larger sizes of taps. It is true that the grinding of screw thread forms on taps after the hardening of the tap has enabled the pitch of the thread to be controlled within much narrower limits than was previously possible, even with ground threads the pitch errors are a material factor in determining screw thread tolerances. Matters have not progressed sufficiently far to say what the ultimate outcome is likely to be except that the work of the committee will clarify the situation and provide tap manufacturers and users with more detailed and precise information on the subject than has hitherto been available.

Jig Bushes, Work Clamps or Clamp Supports.

No consideration has so far been given to the standardisation of jig bushes, work clamps or clamp supports, although in Germany very complete particulars have been worked out for these details.

I shall be glad to have the views of this Institution as to whether standardisation of this order would be helpful to the engineering industry in this country.

Component Standardisation.

	B.S.S.
Bolts, Nuts, and Screws	84, 92, 93, 191, 28, 190, 193, 64, 57
Washers, split pins	28, 325, 190, 191, 193
Taper pins	(Pt. 3) 46
Keys and keyways, splines ...	(Pts. 1 & 2) 46, 5015, 5011
Couplings	5017, 5035
Couplings hose	336
Shaft extensions	(Pt. 1) 46
Ball bearings	292
Flanges (Pipe)	(*Pts.* 1, 2, 3, 4) 10, 3022, 5029
Ropes and pulleys	300, 302, 329, 330, 366, 236, 237
Chain	394, 228, 465
Rivets	425, 13, 14, 15, 24, 275
Gears	235, 436
Wheel rims and centres ...	71, 5013, 5037, 5038
Piston rings	5003, 5023
Pistons	5025
Fuel Strainers	5018
Tubes	24, 43, 53, 61, 385, 3000, 3023, 5009
Sparking plugs	45
Pipe fittings	66, 99, 154
Cast iron pipes	78, 416, 437
Bordeaux connections	461
Bulldog grips	462
Sockets for wire ropes	463
Thimbles for wire ropes	464

The above list of components which have been standardised, together with the relative B.S.S. numbers, does not pretend to be at all exhaustive although it is thought that the main items which are of interest to production engineers are included.

In my view the standardisation of components is one of the most useful phases of the work. Some judgment is required in choosing the best time to put forward a particular detail for standardisation. If it is done at too early a stage then progress may be hindered. Further, if standardisation of a component is carried too far, it may operate unfairly between manufacturers. Taking a recent example as an

illustration: Proposals have been circulated for standardising the holding down holes for fuel pumps for compression-ignition engines. It was also proposed simultaneously to define exactly the position of the governor attachment. This seems to me to be going to far. It would be equally reasonable to attempt to tie down to a specific standard the whole of the connections to carburettors for petrol engines. If this had been done in the early stages of the growth of the petrol engine, it is easy to see that a number of the very efficient carburettors now in use would never have arrived.

In this section again, members of this Institution are in an excellent position to suggest when component parts have arrived at such a stage as to justify standardisation.

Materials.

A large number of B.S. specifications have been issued in connection with materials covered, i.e.: Ingots, non-ferrous alloys, plates, sheets, rounds, hexagons, flats, angles, eyebeams, tees, channels, wires, tubes, rails, forgings, steel castings, iron castings, brazing metals and solders, leather belting, rubber faced cotton belting, conveyor belting, etc.

It is impossible to make more than a passing reference to this phase of the subject, but there is one danger to which I would like to refer to.

In many of the specifications dealing with component parts, complete information is given as to the material of which the component part is to be made and the tests it is satisfactorily to comply with. There is of course something to be said for this practice as it is convenient to have the information all in one publication. The inevitable result of a policy of this kind is that the number of steels called for in the various specifications is legion, so that the steelmakers' problem is definitely complicated. In my view there should be specifications for a suitable range of steels and the material to be used for specific details should be called for by reference to the appropriate steel specification. It is of course certain that as time goes on the list of steels would be added to, either due to action on the part of the steelmakers themselves, or due to committees dealing with new components intimating that they required a steel having somewhat different properties to any of those already on the list when no doubt the steelmakers would take steps to meet the new requirement.

The Automobile Section of the B.S.I. has worked on this basis but they of course had the advantage of the experience of the older efforts of standardisation. Similarly in regard to tests, it appears desirable to have a schedule of standard tests which are again called for by reference and not repeat it in each detail specification. As an illustration of the desirability of this, it may be mentioned that not

long since an error was found to exist in a paragraph in B.S.S.18 dealing with the question of tests. This has been copied into large numbers of specifications of component parts and all these really require bringing up to date, whereas if the tests had been called for by reference, the correcting of the one specification puts the whole matter in order.

I have several times during the course of my remarks referred to the help which this Institution can give in the matter of standardisation and I should like to end up on that note.

The B.S.I. exists for the purpose of aiding industry in this direction and it is certainly organised in a way which should make it a really efficient instrument. There is a general council and under this council are different committees dealing with the various sections of industry. The one which most concerns your Institution is the Mechanical Industry Committee which has on it representatives of all the important manufacturing, consulting, and using interests Attached to each industry committee are a number of technical committees, each of which is dealing with some particular section of the work, and these technical committees are again built up of representatives of manufacturers, government departments, and users, and my experience is that they take their work quite seriously and a lot of effort and intelligence is devoted to the preparation of specifications which will really cover the ground.

It is to be clearly understood that the B.S.I. is not a body which is endeavouring to force specifications on to industry. It is rather an agency of which industry can obtain the co-operation in the formulation of specifications which will be of assistance in securing progress and uniformity together with economy of manufacture.

I occupy the position of chairman of the Machine Tool Details and Accessories Committee and I can certainly promise that any proposals put forward by this Institution for the standardisation of further details or components coming under this heading, will have sympathetic consideration and also that an invitation will be extended to this Institution to appoint representatives to sit on the committee while they are under consideration. The normal work of the members of this Institution is such that they can undoubtedly give valuable help in making suggestions as to the directions other than machine tool details and accessories where standardisation can be pushed forward with advantage to all concerned.

As a last word I would suggest that all members of this Institution should have a copy of the index list of B.S. specifications for reference.

Discussion, Eastern Counties Section.

Mr. F. Ayton (Section President): I am sure you all feel, as I do, that we have listened to a very interesting paper this evening by Mr. Dumas. Mr. Dumas must have impressed you as to the enormous amount of work that has been carried out for standardisation by the British Standards Institution. This work is very thoroughly done and each specification is read over and over again before it is passed for approval. Mr. Dumas has touched on every phase. There is one thing I would like to mention in connection with colouring patterns. We are now back to black. When one has been using another colour one notices the difference that is found with a colour. You can pick out a particular pattern at once against the black sand.

Mr. Hartley (Member of Council) stated that his firm has tried as far as possible to follow the lines laid out. They have found that they have written to suppliers, with regard to spanners, in accordance with B.S.I. specifications and the suppliers have written to say it is not in use. The Institution should try to follow out the rulings of the B.S.I. We want above everything else, to make sure our work is the finest quality, that our metal is right, and to see that all the various tools are up to standard. The end is, that everyone wants to increase their production. All the work of the B.S.I., undoubtedly, leads to that end.

Mr. Brazier: I would like to ask Mr. Dumas one point regarding the heat of the temperature of the rooms where we are measuring the gauges. It has been the general rule to work at about 60°. When you get one operator working night shift and another day shift, you get a variance of their readings of the accuracy of the gauges they pass. There is another item, dealing with gear teeth, the 20° Involute and the 14½°. I would like to know what is the extra efficiency on high speed at 20° over 14½°. Dealing with the tools, there is one item, jig bushes. When there is one jig of one size on a bush, and another to be at a different size, it complicates all tools to find the right one.

Mr. Phillips: Projection is the first place to start standardisation. There is no doubt there should be some definite standard, not only in projection, but on dimensional marks on the drawings, which the workman has to use.

Mr. Garlam said he rather disagreed that the dimensions should be mentioned on drawings with the decimal limit. In the works especially, a fraction of an inch, plus a limit, is quicker and more easily understood by the workman. For instance, 27/64-in., if you put it in decimal form, the workman would scratch his head.

Mr. Murdoch asked if the question of gear boxes had been spoken about with regard to changing all gears one way instead of forward for reverse on some cars and backwards on others. With

regard to jig bushes on cars, Mr. Pomeroy had stated at a previous lecture that the question of tolerance had, more or less, selective assembly and that may be one of the reasons that some motor car firms did not work to the correct tolerances as mentioned by the B.S.I. With regard to spanners, in some cases where one is working to black nuts or black heads on screws, the tolerances on screw is on the large or small side and also a big point is the question of paint on the top of the large tolerance, which a normal standard spanner would not fit. He had a case quite recently of ordering keys. He gave the length and size. He followed the British Standard Specification by measuring the length of the key under the head. As the keys were wrongly supplied the matter was referred to the suppliers, who stated that their practice was to measure keys overall and not under the head.

Mr. Copping : In connection with keys and keyways, the British standards for the depth of keyway in the shaft and the hub and, also, proportions of standard key bars and keys are very close. You have difficulty in producing the correct depth in the hubs and also in the shaft. Of course, the standard key bars we have to put up with. He thought there was room for consideration in arriving at depth. When it comes to the job of producing a keyway in the shaft you have a likelihood of the keyway being cut wide and, in addition, it is very difficult to control the depth. Therefore, he considered that the tolerances allowed on the key bars are very close. He asked if it might be of interest to consider the standardisation of flanges and grinding wheels.

Mr. Dumas, replying to questions raised in the discussion, said that with regard to the colour of drawings, the efforts of the committee have been to make as little disturbance as possible and the present proposals line up more nearly with current practice. Black patterns do not show the black sand markings so easily.

He was glad to find that the angle of 75° has been found suitable for heavy work. He rather understood from what was said that the angle had been adopted on account of the British Standard Specification issued. If all the members who had raised various points would take a leaf out of that book, a lot of corrections would be made.

With regard to projection on drawings, this has been a particularly interesting point. Apparently, one is called the English method and the other the American. There seems to be a lack of justification for that nomenclature, as the American depends largely in practice, on a method that has been used for a hundred years. He thought it would be better when speaking of projection, to refer to it as first and third angle projection. The third angle projection is the one which is looked upon as being rather American, and the first angle, English. What has been done in some cases where the change has been made, has been very definitely to put on each drawing whether it is first or

third angle projection. If any firm contemplated making a change, this practice would get over a good many of the difficulties.

Mr. Hathey spoke about material not being available to British Standard Specification. No doubt there is a certain amount of truth in this. Again, if all users would ask for the British Standard Specification, the suppliers would soon be selling it. Take for example, B.S.S.37 which deals with steels. There is no difficulty in getting that, nor is there trouble in regard to price. Obviously, if only an individual now and again asked for a special specification, manufacturers will not pay much attention to it. If we all ask for it we will get it to the specification.

Re. temperature of room. 62° was the old temperature and 68° the new. One wants to be quite clear in thinking about this question of temperature. The length between the two points on the metal rod at 62° is unchanged. What is changed is that the gauges are now checked at a temperature of 68°, so that if you take a gauge which was exactly right previously at 62° and you now check it at 68°, that gauge will show as being a little too long because it has expanded to that temperature difference. There is a good deal to be said for using 68° as against 62°. Partly it assists international standardisation. If you have a gauge room that you are trying to keep at a uniform temperature it is very much easier to do it by warming than cooling. In the summer there must be difficulty in getting down to 62°, whereas, in winter you can easily get it up to 68°.

Then in regard to use in the shops, broadly speaking your gauges and your work will go up and down together. So that if your gauges are of pretty much the same material as your job, if the temperatures go up and down together, the expansion and alteration of the tool will go together and no serious errors will be introduced.

In regard to the angle of teeth, I think that, undoubtedly, slightly smoother working is obtained with the 20° than with the 14½° but if you will refer to the specification, you will find that there are limits of errors specified relative to different peripheral speeds, so that the whole thing is laid down there and you can be sure if you keep your error within the limits, you are going to get your job.

As to jig bushes, this was one of the things where your Institution might quite reasonably say, "We would like something done." With regard to selective assembly of components for motor cars, there is only justification for selective assembly in those cases where the tolerances, which are necessary from a technical point of view, are exceedingly fine. Where the tolerances are reasonable and present no particular difficulty, then selectivity is not justified. Take gudgin pins and pistons, the limits that you have to work to there are so very fine that selective assembly is used.

Re. spanners and the question of paint and black and bright nuts. The maximum size of black nuts and bright nuts, according to the

tables, is the same, the difference between the two is that larger tolerances in the downward direction are permitted for black than for the bright. Strictly speaking, there should be no more difficulty in fitting a spanner on a black nut than a bright. As to whether the manufacturers of black nuts always stick rigidly to limits, is a question of if you were to say " nuts to be as specification " and if you say this, you will get them to specification.

With regard to the question of ball bearing limits and ball bearings made to metric sizes, frankly, it seems a rather extraordinary thing that we should have in this country 1-in. limits.

Something has been said about depth of keyways. So far as the hub is concerned, it seems that there is pretty accurate control of that.

In regard to the shafting, the practice in our factory is this : We rough turn the shafts ; then the shoulders are put on the shafts in their correct places, and then rough ground to a tolerance of 1,000th. Then the keyways are put in. If you get a shaft which is accurate in diameter to about 1,000th you can then measure accurately from the bottom of your keyway to the other end of the shaft, and that is the neasurement which goes on the drawings. In his factory they do not use any keys which fit in the top.

In connection with flanges and grinding wheels, Mr. Dumas said that this was a perfectly legitimate thing for the Institution of Production Engineers to suggest to the B.S.I. The Institution of Production Engineers is in an exceptional position to state standards.

With regard to fractional dimensions with limits, if you express a dimension in decimals, it is putting an undue strain on a workman to ask him to convert from 16/64ths to decimals.

A hearty vote of thanks was adopted to Mr. Dumas for his lecture.

Discussion, Birmingham Section.

MR. W. G. GROOCOCK pointed out that the memorandum Mr. Dumas had referred to as being issued by the local committee, had been issued in fact by the Council of the Institution. Through its papers committee, it had formulated something for its members to think about prior to the general discussion at the various local sections on the subject of standardisation. It would be noticed that the memorandum, which they had all had, was built up of six questions—six very pertinent questions—since Mr. Dumas, in his lecture, had raised something which really made every one of those questions a vital one. For instance, question (1) was "Standardisation, what does this mean?" Mr. Dumas had mentioned in his opening remarks that he had just found out that certain other members of the B.S.I. differed somewhat in their ideas on standardisation. If that were likely to obtain—and it did obtain—there was a reason why we should have some ideas of standardisation. We should get a better line-up of standardisation if we had a full and free discussion, and that had really been behind the idea of the council in selecting standardisation as being one of the subjects to be discussed by all sections during the present session.

The next question was "Are production engineers sufficiently familiar with standardisation that has already been accomplished?" They had seen from what Mr. Dumas had said that a tremendous amount of work had been done. Very few of them were fully alive to what had been done. He would like to say how much he appreciated the last remark of Mr. Dumas, when he asked everyone to look at the index sheet. This index sheet had recently been re-issued, and was well worth taking home and spending a few of our leisure hours on.

The next question was one upon which it was really difficult for any one to form any concrete opinion, and that was "What are the fundamentals of standardisation?" Most of them, in that respect, took much too narrow a view. If we were asked the question of what we wanted to standardise, we should normally think of some component in our works where standardisation would give us some benefit. But the subject went much further than that, and Mr. Dumas had pointed out, and rightly so, the great external standards which were really associated with the form and symbol of those internal components. What he had been telling them undoubtedly was, the standardisation which the council had in mind when they laid down those series of lectures, and these were the fundamental standards, which were becoming more necessary to-day than ever. Years ago, we made every component we used for ourselves. To-day, very few works are in the position of making

everything they use. They all had to buy certain components from outside, and it was because of these outside purchases that it had become very necessary that articles should be standard, and there should be a more rapid means of recognizing what we meant when we talked about "a half-inch screw," for example. When we asked for a half-inch screw, one-and-a-half inches long, we did not normally set it down as having any features to mention other than that, but if we referred to it as being a screw to conform to B.S. No. 104, then we had something definite that our inspectors would work to, and there could be no complaint if we were to reject those screws or any other component that did not conform to a recognized national standard.

The sixth question was "Is it possible to forecast the line of action for the future of standardisation?" He thought Mr. Dumas, himself had forecasted the line of action. He had suggested that they as an institution, were probably in a better position to put forward ideas on standardisation than any other institution in this country, although he did not perhaps say that. They were actually concerned with the making of articles, and they saw more of the functioning of those articles than probably any other institution, and he was therefore in complete agreement with Mr. Dumas when he said that they ought definitely to set their minds to that problem, of seeing whether they could forecast the future line of action. Personally, he did not know what it was in any particular respect, but he was quite sure that a number of those present would say certain things ought to be standardised. As Mr. Dumas had suggested, there was a line of action which would make it easier to bring about that thought of theirs. We must put our views forward.

Mr. I. H. Wright said that in the early part of his paper Mr Dumas had said something about preferred sizes, and had referred mainly to bolts, and too many hole and shaft sizes. It seemed to him, that if production engineers would consider preferred sizes in a wider sense, it would help them very greatly towards an appreciation of what had to be done in standardising. The ordinary engineer took one of the standard tables of screws or small tools, and looked for a particular tool which he had used for some time, and found it was between two of the standardised sizes, and thinking the list was not complete enough, he rather turned it down. If, in that condition of mind, one began to try and standardise some element which was made in considerable variety of sizes in one's own works, it would be found there were often five or six sizes almost alike, and then a big gap. The idea of preferred sizes begins then to have a really tangible value. The main thing which was gained generally in any standardisation was a reduction in the number of types and sizes, and an increase in the lots which could

be put through of the smaller range that is decided on. Having that knowledge, the engineer was much more favourably inclined towards standard tables as issued by the B.S.I. In connection with this, small tool standardising was made with the object of allowing the purchaser to buy tools from this maker or that, and be quite able to use them directly and immediately in his machines. It did not prevent in any way those tools being made of one kind of steel by one small tool-maker, and another kind of steel by another small toolmaker, and the purchaser could still have the quality of tool he wanted. It also did not prevent in any way the use of improved materials as they arrived.

As Mr. Dumas had said, in forming a standard, it was not advisable to try and standardise material too much. That could be a considerable hindrance to development. Standardising did not interfere with development at all. For ordinary classes, that did not matter to control, standardised parts could be used. For parts that were exacting, or a new thing being tried out, new additions could be made. If they came into general use, the British Standards Institution would include them in their tables if asked to do so.

Mr. Dumas had mentioned the direction of movement of handles on machines, and relative motion of slides. We had not done anything on this in England, though in Germany they had. He thought it would be a very good thing, because it might put an epoch into machine tools, so that if one saw a machine tool with a certain handle moving in the wrong direction, one could definitely condemn it, and the machine tool makers would be quite pleased to replace it!

In respect to the general direction of their standards, he had been looking, in the last year to two, very considerably at the development in Germany, and in Germany they had developed conventions of nomenclature, and direction of machine handles, and things of that sort, rather than systems of limits of holes and threads, and so on. They had done something of that, but it did not loom very large compared with convention standardisation. They had standardised cups, saucers, fruit preserving vessels, and all kinds of things in domestic and building matters. In Germany, one effect of the standardisation of ordinary machine parts had been that certain firms who were particularly equipped for making one particular piece, made it and sold it at a price which another firm, who would only want them in small quantities, could advantageously buy them at, and the result was that firms, instead of making, say, counter shafts for small machine tools, got them for less money from some firm who made them for their own purpose and to sell. A lot of other small engineering elements were dealt with in the same way. The result was, that a firm who were making a certain kind of machine,

bought their couplings, counter shafts, etc., outside, and devoted their whole time to the development of their product.

MR. R. H. YOUNGASH (Section President), said that Mr. Dumas had given them a very rapid survey of the subject. It was an enormous one, and Mr. Dumas had covered such a large area that one could only generalise. One might pick out an item here or there, but he thought it impossible to form a real opinion on his excellent lecture until they has seen it in print.

He had asked himself " Why do we have standards ? " It seemed to him the answer came under one, two or three headings : convenience, cheapness, and uniformity. The difficulty then arose that we had our own particular ideas, and Mr. Dumas himself had indicated this. We had our own particular ideas of what ought to be standards, even on the subject of conventional standards. For instance, if those of them who came in cars were to go out after the lecture and find that all their steering wheels had been made to work the other way round, they would be in difficulties, and yet there was obviously no reason why steering wheels should not be made to work in the opposite direction. That was a conventional standard. It had become a matter of convenience. On the other hand, we had standardisation of uniformity or dimensions. This had been brought home during the war more than at any other time in our experience, when large numbers of engineering pieces were made in shops miles apart, and assembled in another place, and it was found that many of them had to be practically re-made, partly because of temperature variations, but also because, in the larger pieces, tolerance and dimensional variations were a very big factor.

Then came the final one of cheapness. There was no need to stress that point. We were all perfectly well aware of the advantages which arose from a cheapened production, due to the various standardisations we already had. We must also remember the question of individual standards, as against general standards. Take for instance tee slots in a milling machine table. He would mention, in this connection, that one firm had for many years made 11/16-in. the width of the tee slots in their milling machine table, whereas the accepted standard was $\frac{5}{8}$-in. There was no real objection to that, except that one of interchangeability and convenience, and the convenience and interchangeability were purely domestic, because if a company using those machines had nothing else but those machines, then obviously all their jigs and fixtures would fit them. On the other hand, if they had a number of 11/16-in. tee slots, and a number of $\frac{5}{8}$-in., there were difficulties. In setting up these standards, this country had adopted the wisest course, that of referring those matters to a committee of men set apart for the purpose of dealing with them. It was certain that, if it had been left in the hands of the manufacturers alone, no agreement would ever have been reached.

One of the points which had been raised by Mr. Dumas was the question of tapers. He (Mr. Youngash) said he had probably had the usual run of experience and difficulty with tapers, and knew that in this country, until the common use of Brown & Sharpe and Morse tapers, there were no "standard" tapers, many machines being fitted with the makers' own particular standard. One usually found the tapers of Brown & Sharpe on milling machines, and Morse tapers for drills, reamers, lathe centres, and suchlike. Another point which would occur to most of those present was the entire lack of standardization in the size of lathe tools. He supposed that every imaginable size and section of steel that could be obtained had, at some time or other, been pressed into service for lathe tools! There could not be any real need for that.

With regard to Mr. Dumas' remarks on dimensioning tolerances, he heartily and entirely agreed with his recommendations. He did not himself like plus and minus signs at all. He liked the maximum dimension, and limit dimension. Whilst he preferred Mr. Dumas' second suggestion, which was to put them both down, he himself preferred the exact maximum dimension, with the minus sign for so many thousandths. It certainly led to fewer misunderstandings with operators. One point in connection with ground taps which might be worth mentioning was that, in our efforts to produce proper taps, we had ground them, and found that in improving the pitch of the taps we had actually brought about a condition that was not quite anticipated, which was, that the taps themselves did considerably more work. It might very easily be that standardisation in other parts might produce similar results.

Mr. J. A. Hannay (Member of Council), said they were very fortunate in having a gentleman of Mr. Dumas' engineering experience and reputation to lecture to them. He had been behind the standardising committees for very many years, and they could not but feel a great deal of confidence in having a really able engineer directing their thoughts and studies.

The ordinary inventor and designer should know nothing about standardisation, but he should be helped, so far as possible, to design and create. Coming to the sphere with which they, as production engineers, were concerned, they should take full advantage of standardisation. Let them think for a moment of the enormous wealth of information that had been tabulated there! They, as production engineers, had all this at hand. As years went by, more and more of this standardisation would have to be done. He had expected to hear something about screw threads. Really, production engineers ought to look round and take their business and problems as they were put to them and then use the information at hand.

It might interest members to know that since the Birmingham Section of the Institution had been formed, not less than six invita-

tions to the council for members to sit on various committees of the British Standards Institution had been given, so these committees were making use of the Institution. Mr. Wright, for one, was sitting on various committees. Only a month ago, an enquiry had been received for a member of the Institution to sit on the committee for shafts and couplings. He hoped that the co-operation would continue, because he felt that the production engineers were the people responsible for producing the article given to them in the best possible way, and as cheaply as possible. They did not want to waste their time designing and scheming, but to take what was all ready for them.

When the council had met in Manchester the previous week, a small committee had been set up to review all papers read before the Institution on Standardisation and to prepare a report on the subject. He rather shuddered when he thought of the work that had to be done, but he hoped that something really useful would come from it.

A MEMBER gave an instance relating to screw threads, of a certain firm having a stock of eighteen thousand different taps and dies, who received an inquiry for one from Australia, which had to be made specially ! It had just been standardized in America, but had been made obsolete in England in 1914 !

MR. T. S. RUMPH, referring to the standardisation of gear pressure angles, said that, as a production engineer, and one in constant intimate touch with the manufacture of gears, he would say it was a definite advantage, taking nearly any of the regularly used machines, to be able to make them with larger pressure angles, because, with the Brown & Sharpe type, using rotary cutter, it was very difficult when one came down to small numbers of teeth. The same remark largely applied to hobbing, from the fact of the point of the hob becoming dull, and causing interference below the base line, where there should be no contact at all. The more generally used machines, such as the Fellows, were now being operated at a very high speed ; about 600 strokes per minute was now becoming general practice. One had to relieve the cutter on the return stroke so as to avoid rubbing, and it was perfectly obvious that if the pressure angle were larger, one might use a lesser relief movement. When operating at a high speed, it was absolutely essential to get the amount of relief movement right down to the minimum. That was a point which would interest the production engineer, because it was common experience. Mr. Rumph added that he had never known any case where it had not been a convenience on any type of machine to get a larger pressure angle than 14½°, leaving other considerations out of it, of course.

MR. W. TRYHORN referred to the existing standard specification for spanners, and said he had had a case to produce a number of

double ended spanners, and had obtained that specification. He had, however, found the limits unworkable for real production work, and had to take something else. He pointed out that if the specification had to be reconsidered, the matter of box spanners should be considered at the same time, and if the rate of clearance required, due to the fact of variation in the forms of hexagon nuts were to be considered also, some standards on that would be appreciated

A MEMBER asked if there was any reason why there should not be greater movement towards universal adoption of, say, the metric system. In England, in nearly any shop, there were numbers of American machines, and probably there were some operatives present who knew the intense difficulty of obtaining spanners that would fit machines when they were reconditioning, or anything of that kind. If we were to sell machines abroad, as we were trying to do nowadays, it seemed very absurd that we should take our own standards, and take no notice of Continental standards, or those of the rest of the world, which were mainly American. Was there any reason why we should not pay closer attention to the standards of the rest of the world, and try to conform to those standards ?

MR. E. W. FIELD (Member of Council), said he had been rather pleased to hear the earlier remarks of the President, when he endeavoured to point out the enormous number of standards to which we conformed without thinking about them. It would be very difficult to visualise a world without standards ; there would be no manufactures, no anything ! We could not even revert to savagery, because even savages had standards, such as, one pig equalled two wives, two wives equalled several quarrels, and so on.

Reverting to the technical aspect of standardisation, Mr. Field said he was deeply interested in Mr. Dumas' remarks on what he had termed " preferred sizes." There was no question about it, it would definitely cut down the enormous amount of equipment which, of necessity, stood idle because it was not required at the time. In the case referred to of 18,000 different taps and dies, some of them would be largely redundant. On the subject of centres, Mr. Dumas had mentioned 60° and 75°. With the development of high speed cutting, the 60° centre was essentially an angle for safety. On the subject of tapers, he was rather interested but disappointed to hear practically every reference as so much per foot. It was a dimensional reference, it was true, but every machine tool he knew of had its taper device graduated in degrees. The Continental practice, incidentally, was to express it as a percentage of a cone, but even that method gave a calculation to be made before the machine could be set to produce that taper. Mr. Dumas' suggestion with regard to the Institution was an excellent one. He was deeply disappointed that the British Standards Institution had not attempted any method of expressing a standard form of alignment rests for machine tools. There was a

German standard, expressed in millimetres, but it did not help us. Had nothing been attempted in this country to form a standard of that description ?

MR. B. J. WARE, in proposing a vote of thanks to the lecturer, said he had been astounded to see the charts at the commencement of the lecture, and had wondered whether they would get through them in one evening. Mr. Dumas, however, had taken them through very skilfully, although each one of them ought undoubtedly to be discussed by the members of the Institution in detail at some future date. On the standardisation of conventions, they had all come up against the problem of not having sufficient information on drawings at one time or another. They would say certain things were to be made from cast iron, without saying what sort of cast iron. One firm he knew had made a practice of giving certain definitions for certain types of metals, and also for bronzes and non-ferrous mixtures which was a better method. He referred to a remark made by Mr. Dumas to him many years ago that "A drawing is not a drawing until it tells you everything." They all knew cases where drawings told only half the story, and he was pleased to see that it was one of the things which had been taken up and standardised.

MR. DUMAS, replying to questions raised in the course of the discussion said that although he had been interested in standardisation for a very long time, when he had been asked to prepare a lecture, he had not really any idea as to the form which the lecture should take, and it had required a little thought to split it up into the various sections he had put in front of them. He had endeavoured to put it in such a way that there would be a sort of sequence, and also that they might see there was a very considerable part which they, and their Institution, might play in assisting still further to build up that structure and strengthen it.

He would like to thank Mr. Groocock for his appreciative remarks, and also for correcting him on the point that the memorandum was prepared by the Council. It was a very excellent memorandum, and well repaid study. Mr. Groocock had been kind enough to call attention to the way in which some of the points were dealt with. He had referred to the fact that the Institution should study on what its future action was going to be anchored, that was, on the question of standardisation, and he entirely agreed with his statement that it was the special responsibility of the Institution to take a broad view of standardisation matters. It was certainly true that this Institution, above all others, could give very great help because of the nature of their daily work. In fact, he would say that not only in regard to new specifications could they help, but also in ensuring the observance of existing specifications. He suggested that if they looked more fully into what had already been done, they might profit by it a great deal more than they had done in the past, and

it would be to everybody's advantage that they should take such an action.

Mr. Wright and another speaker later had referred to the importance of each concern having its own list of preferred sizes. He himself had emphasised that a good deal in the paper, and was glad to see his view had been endorsed.

In regard to the standardisation of machine tools, there had been a question of the marking of degrees on the compound slide rest. In this connection, at a recent meeting of the gears committee, they had under consideration the question of how they should express a certain feature of the bevel gears, and agreed they ought to do it in such a way that the measurement could be read off directly on the compound rests of the lathes. It was decided that everybody should have a look round to see how the compound rests of the lathes were marked, but the result they got did not help at all. They were marked in all sorts of different ways. If this feature had been standardized, then the work of the standards committee dealing with bevel gears would have been very much simplified, because they would have been able to develop a specification which would fit any kind of machine tool on which work had to be done. Unfortunately, however, a method of expressing the measurement had to be chosen which would suit some people, and not others.

He was very interested in the chairman's remarks, and in regard to the tapers, it was agreed that the Brown & Sharpe taper was too slow, but he felt that we should probably, in this country, have to follow the lead of the Americans in that particular respect. We were already committed to American tapers, Brown & Sharpe, and the Morse taper, and he thought that if we made any change we should very likely have to follow what they had done. That had already been done, as he had indicated in his remarks in regard to milling machine noses, and he believed it was being found very satisfactory in use.

In regard to lathe tool sizes, there was no reason why some work should not be done in that direction, and if the Institution were to make representations to the B.S.I. that they would like that work done, there was very little doubt it would be taken in hand.

He was also interested in the remarks made about ground taps. As a matter of fact, his standby job for the last two-and-a-half years had been work in connection with screw thread tolerances, and he might say he had gone more deeply into the subject than perhaps anyone, and he had been surprised to find how little the subject of screw thread tolerances was apprehended even by those people who were specialists in the matter. He hoped they might be able to make some definite progress. At any rate, there would certainly be something appearing which would, as he had said in his paper, clarify the

situation, and make the subject more fully apprehended by engineers generally.

Mr. Hannay had spoken of the assistance which the Institution had already given to certain B.S.I. committees. He looked to the representation of the Institution on the committees as something which would inevitably and necessarily be to the advantage of both.

He had been very pleased indeed to hear Mr. Rumph endorse the choice of the 20° pressure angle. He entirely agreed with his remarks, and if Mr. Rumph had been at the meetings of the sub-committee dealing with that matter, he would have heard his views very fully expressed and endorsed. Perhaps Mr. Rumph had had the specification in his hands, but if not, he would find the formulæ given in the specification very interesting reading.

One of the particular points Mr. Rumph had made had not come up in committee ; it was the minimising of the necessary amount of movement of the gear wheel which was being cut on a high speed Fellows' gear shaper, by using the bigger pressure angle. The force involved in movement, as they knew, varied as the square of the speed, and consequently, if one could cut down the amount of movement it quite directly followed that one could adopt successfully a higher speed of working, and that was a reaction which resulted from the use of the larger angle. Clearly one could not sacrifice the technical soundness of the part to a consideration of that nature, but it was fortunate when the technical considerations simplified the production problem.

In regard to spanners, he was not surprised to hear that the existing tolerances had been found uncommercial. He might say that the tolerances in the new list were very much in excess of those at present prescribed, so that the manufacturers' proposition would be much easier, and even if there happened to be a coat of paint on the nut, the minimum size of the spanner ought readily to engage with the nut. Box spanners had not been dealt with so far, but there was to be a meeting of the spanner committeee the following week, and he would raise the question at that meeting. It seemed clear that, with box spanners, one could give rather more clearance, that is to say, the minimum spanner might be more in excess of the maximum size of the nut than was the case when dealing with just a simple jaw spanner, as one would be in contact with all the corners more or less at the same time.

A question had been raised about the metric system, and in relation to American machines, the Americans had not found any particular difficulty in selling their machines anywhere in the world, and the American machines were made on the inch basis.

It was true that the standard American nuts differed somewhat in size from the British nuts ; on the whole they were smaller ; but he assured the speaker that if he were to suggest to the bolt and nut

manufacturers in this country that they should conform to the size of nuts standardised either in America, or on the Continent, he would have a very difficult job ahead of him. He had been at several meetings where those people had been present expressing their views, and they certainly had at the back of their minds the idea that if they made a nut in their own particular size, when the purchaser wanted another one he would have to come back to them. He had pointed out at the time that they had not adopted at all a broad view of the position, but he would, personally, hate to have the job of convincing them that they ought to change. It was unfortunate, since America and England were both working on the inch basis, that our nuts were not interchangeable either in respect of size across flats, or in respect of threads, but he did not look for very much progress in that direction.

Mr. Field had spoken about the 60° and 75° angle for the centres, and had expressed the view, that, under modern conditions, 60° was the right angle. He entirely agreed with this, and also that the centres had got to be made sufficiently deep. He was quite satisfied that some people who had trouble when making a 60° angle, just got it because they did not make the centres deep enough.

With regard to taper per foot, it was probably a case of " as it was in the beginning." All the old tapers were expressed as so much per foot, and one would still find taper pins expressed in that way. Tapers on keys were expressed in that way also, so that it had got in rather deep. He had seen a most interesting example of this in a German publication. They were doing some standardisation, and were expressing pitch tolerances in so many μ's (that is, thousandths of a millimetre) per 25 millimetres of length. Obviously the reason was that the first thread which had been standardized was the Whitworth, and the Whitworth thread was on the inch basis, and an inch was 25.4 mm. Consequently, Germany had taken 25 mm., which was the nearest whole number, as their length on which to base pitch tolerances, and that was in a proposed standard not yet published. It did show that when a thing was started on given lines it had to go on, and that it would persist.

There was a very excellent book, which had been referred to, published in Germany, dealing with accuracy tests on machine tools. If that was wanted, there again it was a question of the interests involved making requests to the B.S.I. that something should be done. There were the machine tool makers and users ; there was the Institution ; both proper bodies to send in a request of that kind. If it was done, he thought it would probably come on to his plate at the B.S.I. because he was the chairman of the Machine Details and Accessories Committee, and that was probably the committee to which it would be referred.

There was one thing he had been rather expecting to hear raised, and that was, the first angle and third angle projections. At Ipswich, where he had also given his lecture, two or three people had spoken of this, and one speaker had said that he had known of quite a considerable sum of money having been lost due to mistakes arising from a misunderstanding as to the way in which the views were presented. Another one had said that his firm had used what was generally known as the American method of projection for a hundred years, and he doubted whether they would be inclined to make any change. He had suggested that it would be perfectly feasible to make a change if they made a note on each drawing as to the angle of projection which was adopted on that drawing. In his opinion, it was a matter on which the Institution ought to have views, and a policy, and he would suggest it would be very interesting for them to follow up, and find out just what practice was most common among the firms with which they were associated. Also, they might have a discussion on it at a later date. He would also suggest that, in considering it, they might equip themselves with the B.S.I. specification, and if they adopted an active policy, he was sure that very important progress would be made.

STANDARDISATION.

Six Papers. Presented to the Luton, Bedford and District Section by Members of the Section Committee.

Part I—STANDARDISATION, WHAT DOES THIS MEAN? By R. A. Wright, M.I.P.E.

THE term standardisation is perhaps an unfortunate one since it immediately conjures up in one's imagination visions of costly commissions and lengthy research work, whilst the immediate net results to the average man in the street appear to be the death of private enterprise and the sinking of all individual efforts into one vast co-ordinated pool. A further factor which militates against a more general feeling in favour of standardisation is that it becomes the, shall we say, privilege of a body or association to dictate terms of manufacture. That this is no idle statement is amply proved by the general feeling still existing amongst some manufacturers when they are asked not only to tender but actually to produce an article which in every way conforms to a selected standards specification.

One of the main reasons for this lies, as far as I can gather, in the fact that everywhere in industry where the necessity for standardisation has arisen it has had first successfully to negotiate the discrepancy arising in existing sizes and ratings, this having nearly always been done in the first case at random by manufacturers of a new product, and generally without any reference whatever to the economic phase. When efforts are made, therefore, to establish standards, then, of course, the handicap develops due to the clashing of individual interests, which is naturally unavoidable due to very large investments having already been made in tools and existing stocks. Yet, whilst we all deplore the term standardisation, no adequate substitute offers itself and we are left therefore to argue its possibilities. That it undoubtedly is advantageous and gives a filip to trade in general where applied will I hope be more apparent at later stages in this paper.

Perhaps the greatest objection so far, which has always been put forward whenever standardisation is mentioned, is that it has a great retarding effect on progress inasmuch as it provides unbreakable and unalterable specifications. However, nothing is farther from

8th February, 1933.

the fact. In order to make this clearer, standards can in general be split up into two main groups, the first—fundamental or basic standards, and the second—engineering or domestic standards. It is my intention to try and deal briefly with these two groups.

The first named, of course, is the one responsible for the allegation regarding braking effect on progress and also unalterability, since it will be realised fully that to have alterable standards on which the complete trade of the Empire has been built up would be, to say the least, suicidal. Whilst on this subject then, it would be perhaps of interest to many to define a few of the more generally accepted basic standards in everyday use, as, for instance, the distance between certain graduations on a bronze bar at a temperature of 62°F. is known as the Imperial Yard, whilst the weight "in vacuo" of a platinum mass is known as the Imperial Pound, and the eighty-six-thousandth-part of the mean solar day as the Second of Time. These units of length, mass, and time form the basis for calculating the units of electricity, etc., and their theoretical and practical definitions and counterparts are held in the safe custody of the National Physical Laboratory, Teddington. Naturally, the above-mentioned standards are fixed irrevocably by Acts of Parliament, and, therefore, except for periodical examination and recomputation are definitely kept in places of safety, and accurate copies used only for everyday practice.

In dealing with the second group, namely, industrial standards, in which we are more interested, these of necessity have to be arrived at in a very different manner, the reason for this being, except in very few instances, that they could not be effectively dealt with by governments and would provide for such an immense amount of legislation as to be impossible to surmount. So in Great Britain, and, I believe, in many other countries, standardisation began in a number of small private concerns, and was found to be of such great benefit as to warrant the expense of carrying out by entire industries. Therefore, to reach any degree of efficiency and so confer a benefit which could be readily proved to the country at large, it was necessary to transfer this power to some central body where the organisation for properly co-ordinating the information required could be carried out efficiently.

Obviously it needed not only a definitely impartial organisation, but one vested with the necessary power to carry out its work without being dependent on any one concern or liable to be swayed by policy. This state of affairs, therefore, called into being what is known to you all as B.S.I. or the British Standards Institution, whose aims are the general classification and unification of specifications covering a very wide field in the trade of the country to-day.

To give you some little idea of how wide this field is, may I quote four examples only: one, rolled steel sections for structural purposes; two, portland cement; three, definitions of yield point and elastic limit; and, four, lamp black as used for paint.

Industrial standards which deal with limits and exact sizes are very little heard of by the average man in the street, yet to quote only one instance, the automobile industry, the incalculable benefit standardisation has conferred has brought the motor vehicle within the scope of the great majority. Yet the curious part of all this is that the ultimate user hardly ever considers what standardisation has done for interchangeable manufacture and mass production, and takes all for granted, without ever giving a thought to the immense amount of preparation and labour which has been involved in the preparation of a standards specification. Let us now consider for a moment a few of the comforts which we are able to enjoy through the medium of work carried out by the British Standards Institution.

Take for example the case of the electric light globe. It is very gratifying and comforting to be able to walk around to the nearest dealer without having first to make accurate and hasty measurements, and to be able to purchase over the counter with a minimum of delay a new lamp, or a replacement, return and fit it without having to resort to the aid of an outside electrician or a home workshop. Also consider how this has affected cost. Manufacturers, of which there are many, are able to keep their works in constant employment, safe in the knowledge that they are making not only for present demand, but for stock, which will all be consumed when the orders come round again, which they must of necessity do. A still further aspect is also the equipment of such factories, the machine tool builders, knowing that an effective design of machine will be in demand by the makers, are able to concentrate more attention, and devote more money and time, to the perfection of a machine suitable to the particular branch of industry. This in its turn can be produced more economically since the standardisation of the part to be produced goes a long way toward standardising the machine itself. That this is very apparent is made clearer by a study of some of the latest productions of the foreign machine tool builder who, I regret to say, is in my opinion more alive to the possibilities.

Lastly, where the buyer is concerned, the British Standards Institution specification offers a very fine basis for comparison of tenders. As an example of which take a purchaser requiring steel rolled sections for structural purposes, he is able definitely to state that they must conform in every way to the British Standard Institution specification 1/1920. He is absolutely assured that, whatever the price variation, size, weight per foot, and carrying

capacity will be identical, and he can therefore avail himself with safety of the lowest price. This example I hope will give the lie to the idea prevalent among many people to-day that standardisation is the prime cause of much of the unemployment and general stagnation through which we are passing at the moment, and perhaps has been confused with rationalisation of which we hear so much.

Therefore, I think we can say with comparative safety that instead of interfering with general industrial activity, standardisation, when surrounded by the necessary safeguards of review and revision, is one of the most constructive movements possible to imagine. Moreover, it enables all the varying interests to get together and results in a valuable service to the community.

Part II—ARE PRODUCTION ENGINEERS SUFFICIENTLY FAMILIAR WITH THE STANDARDISATION THAT HAS ALREADY BEEN ACCOMPLISHED? By R. Allen, M.I.P.E.

THE section of the subject allotted to me places me in a dilemma. If it is stated that production engineers do not know enough about present standards, you might conceivably make me a martyr to the cause. On the other hand, if you do know enough about the matter, there is no need to be wasting your time; nevertheless, from the remarks to follow it is hoped that something of use may come to light, and it will be indicated that a mere surface knowledge of existing specifications is not in itself sufficient.

First of all, everyone directly connected with the production of manufactured articles, from the designer to the shop foreman, should take an interest in their standardisation, and suggestions, whether constructive or otherwise, should be openly put forward. It serves no good purpose to tell your nearest friend confidentially that the designer, or someone else, did not know all about the job, or that the standards committee obviously made a mistake in omitting you from its deliberations.

It is not, of course, compulsory to make use of British Standards Specifications, but it would be a great pity to simply glance at and then file them with the hope that they will pop out on your desk just when really wanted. My first suggestion, therefore, is to get hold of all the specifications that are of interest to you, apply them where you possibly can, and, if you are ordering parts from outside quote the Standards Specification. You will then have no doubt whatever about what to expect from the goods you obtain. By this means you will save endless worry, for you will be drawing on the concentrated experience of many.

British Standards Specifications already issued.

How many of the British Standards Specifications are you familiar with? There is no need to enumerate the hundreds already issued, and I cannot do better than refer you to a very useful publication, namely, "The Indexed List of British Standards Specifications and Annual Report, July 1932." In addition to a complete list of the specifications issued, it contains much information regarding the British Standards Institution, and you can obtain it for the small expenditure of 1s. 0d. The specifications themselves usually cost 2s. 0d., and this small sum should not deter your firm from getting

a sufficient number of all copies of interest for distribution among the staff ; it will be money well spent.

Distribution of Specifications in the Works.

I am of the opinion that it is not lack of desire, but rather lack of knowledge that this mass of valuable data is available, which is acting as a brake on the fuller and more widespread use of this latent source of engineering economy and helpfulness. In every works an individual or department should be given the responsibility under, say, the control of the technical manager, for the distribution of specifications and the collection of all suggestions relative to existing and possible future standards. It would be the duty of this department to see that designers, draughtsmen, tool drawing office, works' personnel and, not forgetting the buyer, are made familiar with all specifications concerning them, so that as many manufactured parts and purchased parts as practicable would come into the category of British standards. This department would also see to it that either by direct representation on the various committees, or by correspondence with the Standards Institution, the proposals and suggestions of the firm were given consideration.

Principles Governing British Standards.

The final product must be the basis of all standards, and the final use of the product the criterion by which the effectiveness of the standard must be judged. If a new or special part is absolutely essential—well and good—but if a standard part can be substituted without adding expense or decreasing the usefulness or efficiency of the machine as a whole, then by all means use the standard part, It will save trouble in getting replacements, relieve everyone from the worry of carrying a special stock of spares, and be more economical in the long run. All unnecessary types and sizes should be eliminated, and, if the drawing office does not see to it—gentle pressure will work wonders !

It is one of the principles of all standardisation carried through by the British Standards Institution that periodic review and revision should be undertaken to prevent crystallisation and to keep the specifications abreast of progress. Other guiding principles are :

Specifications should be in accordance with the needs of industry, and fulfil a generally recognised want.

Community of interest of purchaser and consumer should be maintained.

Specifications should be arrived at by general consent.

Arising from these finger-posts to the practical attainment of workable standards, I add these comments :

(1) In order that a specification may not be one-sided, everyone concerned should submit ideas and suggestions through recognised channels.
(2) Such suggestions need not be confined to minor modifications, but may include deletions, additions, proposals for redrafting, in fact, anything of a helpful nature.
(3) Bearing in mind that the user is the ultimate critic of the product, the manufacturer must not expect that sweeping changes will be made to suit his convenience, unless, at the same time, the user's needs are satisfied.
(4) Ideals are not aimed at, but rather the best practice consistent with minimum expense and disorganisation.
(5) Specifications are not intended to interfere with initiative and invention.
(6) The manufacturer should be left with as much freedom in production as possible.

My own experience as a member of various British standards committees during the last ten years indicates that these principles are often lost sight of, that detailed and intimate knowledge is occasionally conspicuous by its absence, and that because of this, individuals with particular axes to grind are able to force decisions not necessarily to the general good.

International Standards.

At one time, not so far in the remote past, there were many things of British origin regarded as the hallmark of excellence in engineering all over the world. There are still many such things, but it is well to remember that to-day there are other forces at work—keen engineers in other countries forcing the pace. It is, therefore, to our own advantage to recognise that, where feasible and desirable, a British standard should aim at being also an international standard. An international standard means international interchangeability, and, as such, in my view, need not curtail but may even help to extend national trade. The national stamp can be given to the international standard by impressing on it the virtues of quality, finish, and characteristic design without interfering with the interchangeability of the product.

As a member of a concern of international activity, with factories in many countries, and a sales organisation in most, I have had the value of universal standards brought home very forcibly. Few will refute the convenience and economy of at least some of the standardisation already achieved nationally. It would be futile to contend that greater benefits will not be derived from their universal acceptance. Surely the old idea of introducing special parts with the idea of forcing the user to come to the original source for replacements is now out-of-date? Other things being equal, would you

not rather purchase a machine for which you are least restricted in obtaining component parts, than one for which the obtaining of these parts places you at the mercy of the original maker ?

If the work of Whitworth on screw threads, of Skelton on structural steel sections, of Taylor on optical screw threads, of Newall on limits, and that of many others in various fields, has any meaning or usefulness at all, then that meaning must have more than local or even national significance.

It is submitted that all the points touched upon are essentials to be kept to the fore if you wish to claim truly that you are sufficiently familiar with what has been accomplished. The issue is in your own hands, and this Institution as a body, or the members individually, should be able to exert considerable influence on future standards.

Part III—WHAT ARE THE FUNDAMENTALS OF STANDARDISATION? By R. W. Bedford, M.I.P.E.

MY contribution to this paper will, I am afraid, be made up of generalities, and my remarks overlap those of the previous speakers and of those you have yet to hear, but still I offer to you a few random thoughts which have occurred to me on the subject of the title of this section of the paper in the hope that they may be of interest.

One of the fundamentals of standardisation is to provide a specification, which while not being too costly to adopt, provides a generally suitable standard of performance, quality or dimension. This helps to eliminate redundant qualities and sizes, and enables manufacturers to provide stocks during slack periods, and purchasers to obtain their requirements more rapidly. Standards should be in accordance with the needs of industry and fulfil a recognised want and the interest of both producer and consumer must be maintained and standards arrived at by general consent. Periodical review and revision should be undertaken to prevent crystallisation, and keep the work abreast of progress.

A standard of quality for a given material necessarily takes into account the purpose for which the material is to be used. To set the standard too low results in losses, poor efficiency, and even loss of life. To make it too high may result in the same thing, that is, the material must be suitable for the purpose intended, therefore standard specifications for materials should enable the user, first to select intelligently the material best suited for the purpose, secondly to specify it in terms the producer cannot mistake, and thirdly to make the necessary tests to ascertain whether or not the material supplied is in accordance with the specification.

Another essential of standardisation is the commercial elimination of unnecessary variety of sizes, dimensions, grades or qualities, in order to reduce the economic waste resulting from the production and distribution of too many varieties of the same class of goods. Advantages gained through such simplification by the manufacturers are decreased production costs and selling expenses, smaller stocks, faster turnover, and better profits. Consumers benefit by standardisation through lower prices, improvement in quality of product and in the service of supply.

One of the best examples of this is the standardisation of thread systems. Some of us are old enough to remember the confusion which existed before the general adoption of standards for automobile, instrument and metric threads, and when the Whitworth

was the only known standard. Designers consequently specified threads to suit their requirements without regard to the facilities for producing them, with the result that screw cutting was practically confined to the lathe and was a skilled man's job. Standardisation has now so simplified this that dies, hobs, chasers, including gauges for checking, can be obtained commercially for accurately producing threads for all the recognised thread systems. A further fundamental of standardisation should be "definiteness."

In most specifications the terms are sufficiently precise to enable them to be worked to and checked accurately, but I am of the opinion that a good deal of work has yet to be carried out to simplify and define hardness specifications. The three best known systems are the Brinell, Rockwell, and Scleroscope, all of which are good, but each have their limitations in that they are not equally applicable under the same conditions, and also that the recognised conversion tables are not sufficiently precise to enable the hardness measured by one method to be accurately checked by the others.

The Brinell is usually taken as the standard hardness number specified. The Rockwell and Scleroscope are not guaranteed within plus or minus 10 per cent., so that taking a Brinell number of 423 = 92.5 tons, the Rockwell reading would be found within Brinell number 465 to 381 equalling 101 to 83 tons. This, of course, would not be nearly close enough for practical purposes, and the actual comparison figure must be found by experiment on the different metals tested.

It seems reasonable therefore to suggest that there should be closer co-operation between standardisation authorities. There are still too many accepted standards for the same class of goods, some set by trade associations, others by government departments, and again by municipal authorities. I have in mind a water fitting where the dimensions for a screw thread according to a specification accepted by water engineers is minus .002 inch whereas the specification laid down by the Ministry of Health is plus .002 inch. I am sure this opens up a wide field for discussion, for we all suffer in some respect from overlapping and redundant specifications.

Part IV—CAN STANDARDS ASSIST THE PRODUCTION ENGINEER, AND IF SO WHAT SHOULD BE STANDARDISED? By W. M. Pudge, M.I.P.E., Member of Council.

UNDER this heading reference is made to the standardising of methods of projection on drawings and to the fact that there is still a definite need for a unified method of dimensioning and also of indicating finishes.

With regard to dimensioning, I am all in favour of a revision, although personally I am unable to offer any suggestions which show any advantage over the system now in vogue. I am, however, prepared to support any propositions which may be put forward that will mitigate the disastrous results which often occur through a badly dimensioned drawing. There is definitely room for improvement in this direction, and if a unified method can be devised which will make such occurrences less prevalent, much will have been accomplished.

Reverting to standardising the method of projection, this is a phase of the subject I would approach with rather more caution, particularly in view of the fact that both first and third angles are used in this country, and probably each have their advantages. In view of this, therefore, and in order to avoid confusion, I would suggest that all drawings are clearly marked with the angle in which projected. This, to my mind, would obviate the necessity of trying to convert the two schools of thought to one opinion. It would be quite different were we confronted with this country only; in this instance a standard could quickly be arrived at, but here we are dealing with the only universal language. More is the reason for standardising, but how is such a feat to be accomplished? Where is there a body sufficiently competent to handle a subject of such huge dimensions with any hope of reaching agreement? I ask this advisably and not from any lack of appreciation of the efforts or capabilities of the Institution of which I am privileged to be a member, but that this phase of the subject is so controversial, that even were it possible for a standard to be fixed through the ramification of the various Institutions which may be interested, what is to prevent individuals in the far flung corners of the globe from adhering to the method to which they are accustomed?

Whilst on the subject of drawing, I would like to raise another point, this time, not one of standards, but equally valuable. It is, for closer co-operation between the shops and drawing office. Herein

lies the source of a great number of our troubles, which might be avoided, by a frank exchange of views on the subject, by the departments concerned.

So far as machine tools are concerned, this is a very broad subject, and therefore in this short paper, I can only hope to approach the fringe of it. I am, however, of the opinion that standardisation as we understand the word to-day, has failed to attract makers of the normal type of machines usually associated with general engineering work in the past, and has even less opportunity of being of assistance to them to-day or in the future.

For years past, we have had lathes with various sized spindle noses, solid and hollow spindles of different diameters, right and left hand screw operated tailstocks, leadscrews of varying pitches, all for a given height of centre. These idiosyncrasies in other forms were and are to be found in shaping, slotting, milling, grinding, boring, and, in fact, most tools of this type to-day. There must, however, be some reason for these divergencies ; prime cost has of course some bearing on the subject, but the governing factor, I maintain, lies with the designer and consequently the introduction of the human element on which it is impossible to impose standards, even if such existed, without frustrating endeavour and retarding progress.

There are of course exceptions. An example is to be found in all drilling machine spindles, which are bored to the Morse standard. This is an international arrangement. Why a similar system does not obtain for milling machine spindles and arbors I am at a loss to explain. Here is an instance where some universal standard of taper would be of immense service to all concerned.

Reverting to drilling machines, these, peculiarly enough, have of late, in certain forms, become the subject for standardising by various makers, who are now producing motorised ball bearing drilling units, which may be incorporated on any type of fixture for work within their capacity ; other instances may be cited, but the percentage is so low, as to be almost negligible. Proof of this is not lacking either at home or abroad, if we study the current practice of the leading makers, who apart from their standard products are now concentrating on the building of multi-process, single purpose machines, in the design of which may be incorporated all those advantages which make for effortless high production, such as high speed tools or cutters, electric or hydraulically driven spindles with instantly variable speeds, air and electric chucking, hydraulic feeds with remote control, etc. Such a tool may be practically fool-proof when used in conjunction with suitable jigs or fixtures ; its floor to floor time on any given piece may be maintained almost indefinitely, except of course for periodical tool setting. Obviously from such a tool the operator must be less fatigued at the end of a shift and,

therefore, less prone to those ills which befall one not so fortunately placed.

The building of such tools as these is rapidly rendering obsolete the majority of our preconceived ideas on machine tool design, chiefly owing to the rapid advance made in cutting and alloy steels in the last few years, and of which we learn more, almost daily. These have necessitated, in order to obtain the best results which the makers claim, much heavier and more rigid frames, often not in cast-iron but semi-steel, larger spindles mounted in ball or roller bearings, tool slides and much more rigidly supported, together with high pressure lubricating and cutting oil pumps. In connection with the former, these are now usually direct motor driven and maintain a continuous supply to all the principle bearings of the tool, being housed over a sump in the base of the machine.

Should the machine be hydraulically controlled, in either the spindle or feeds, a further pump is incorporated to operate same. This may be driven by electric motor or other suitable means, and in some instances a fan or other method of cooling the oil is arranged for, in the layout.

These multi-process single purpose tools do not, however, stand pre-eminent in this disregard for conventional design, except in so far that present day designers have the added advantages derived from much modern scientific research work. It has always been with us, and is manifestly clear if we observe how different manufacturers have tackled the same production problems from entirely different angles, when given a free hand. To quote a few instances, let us take helical bevel crown wheels, as used in motor car rear axles. These are produced, as we know, identically on both the Gleason helical bevel gear generator, and also on the Reinecker helical bevel gear hobbing machine—quite dissimilar machines. A further example is spur gears. These have for years been produced on automatic gear cutting machines, Fellows gear generators, and hobbing machines. Incidentally the Fellows machine was the solution to our cluster gear problems. Again, on chucking jobs, identical pieces can well be looked after on the Ryder and Bullard vertical automatics, and also on New Britian automatic chucking machines: here are horizontal and vertically operated tools and quite different in their conception. The same remarks apply equally to Lees-Bradner as against Maag gear grinding machines. My reference to the various makes of machines, which are designed for relatively producing the same job, is not made with a view to my discussing the advantages of one against the other, even if they exist, but solely to consolidate my point that had the designers of them been governed by any predetermined standards, this wealth of ingenuity in design and construction, if not lost to us, must have suffered sadly through its influence.

Should the reasons I have already enumerated fail to confirm my theory that standardisation cannot assist machine tool manufacturers at this period, owing to the state of flux in which they find themselves, brought about by the rapid progress made in the science of metals, etc., we have yet to take into consideration the electrical side of the industry. Here, we are constantly hearing of modification and improvements in electric motors, automatic control gear and the like. This being so, we are now able to incorporate constant and variable speed motors in machine tool design, where previously they were ruled out, on account of bulk. This reduction in size has been made possible to a great extent by the much improved insulating materials that are now available, small items when considered individually, but far reaching in their effect on the finished component. These electrical power units readily lend themselves to main spindle drives, also table feeds and other movements, and by arranging for their inclusion in the layout of a machine tool a considerable amount of mechanical detail may be obviated or simplified, with the consequent reduction in building cost, and certainly facilitates handling, when, as is usual, push button is the method of control.

Before passing from the question of machine tools, I should like to pay a tribute to the manufacturers of ball and roller bearings. These concerns have not only brought their products to a high pitch of standardisation but have in a large measure made possible the high spindle speeds which modern cutting and alloy steels demand. Other characteristics in their favour are ease of replacement when necessary, low initial cost, almost entire absence of the lubrication problem, and a considerable saving in power consumption.

The last subject under this heading refers to the standardisation of engineering catalogues. We all know how advantageous this would be to us, but I would not go so far as to say that because a certain maker's catalogue does not fit my bookcase that I do not use it, as it may quite easily be the most useful I have. Here again we are up against the products of many different nations. It is quite conceivable, however, that through a competent body selected to advise on the subject in this country, similar institutions to our own in other countries might be approached with this end in view, but it would appear to be an immense task for the advantages derived, and must take years to accomplish, as catalogues these days are costly to produce, and therefore new editions are not often forthcoming, neither are they necessary, if they are of the loose leaf type, in which additional leaves may be inserted from time to time, as occasion demands.

Part V—COULD WE OBTAIN CLOSER CO-OPERATION TOWARDS STANDARDISATION THAN ALREADY EXISTS?

By S. Gilbert, M.I.P.E., Member of Council.

VERY good co-operation is maintained between the engineering department and the production engineer in an automobile factory by frequent interchanges of visits. The first information obtained by the production engineer from the engineering department is in the form of a production release. It has often struck me as a colossal waste, from both time and money points of view. Production releases for some parts may be issued as short a time as four months away from the date we have got to put the vehicle in the hands of the public. As regards alterations to design to facilitate production, these save both time and money if made at the scheme stage of design. It would be an excellent thing in any firm to keep resident in the designing department a competent production engineer whose duty would be to advise on the production cost of parts at the scheme stage. Referring to one or two shortcomings of the car designer, take motor car control pedals. I think it should be possible for a joint committee of say, our Institution, the Institution of Automobile Engineers, the Automobile Association, and the Royal Automobile Club to standardise these and their position, if only in the interests of public safety. I cannot see any reason why that should not be possible with joint efforts. Co-operation between the production engineer and the automobile engineer is needed.

If you were to lift the bonnets of six different types of cars you would find six different patterns of control joints, and if you crawled underneath, six different patterns of brake rod jaws. These could all be standardised over a wide range of cars with an enormous production cost reduction.

Take tool maintenance cost. With reference to obsolescence cost caused by non-standard parts, it is like the old saying, "Big fleas and so on." You pay extra for non-standard tools to produce them and pay again for the non-standard tools left on your hands when the non-standard parts become obsolete. You are left with several hundred pounds' worth of perfectly good special tools rendered useless when special parts go out of production which have to be kept in stock. We may use them some day. If we had been able to use standard tools on these parts we should never have been faced with that trouble. I am going to pass some standards

books round in the hope that they will give you some idea of how far the engineering side of standardisation can go in a large organisation.

With reference to machine tools equipment, from the relative points of view of the manufacturers and the production engineer, one speaker has touched on a very sore point with me. That is machine tool spindle noses. I will show you what I consider the ideal type of spindle nose for any machine which carries its work on a rotating spindle. I believe this is practically standardised by one firm in the States. Referring to this type of spindle nose, I think it should be standardised. Your fixture is then accurately located on a decent-sized diameter of register. One previous speaker raised the question of electrical and air chucking equipment for machine tools. Considering electrical equipment for machine tools, when you decide to buy a machine you are concerned with standardisation. The first thing that happens is that the maker of the machine writes in for a print of the make of the motor you wish to use. He then writes again and says that you cannot use this motor because the machine frame will not accommodate it. Finally, you get something agreeable to both of you. Regarding a standardised type of hand-wheel, that is very desirable. I should like to go a little further along this road, and standardise the position of speed and feed control-handles on the machine tools of similar type, e.g. drilling machines.

To leave the engineering department and equipment supplier, consider the production engineer and process standardisation. Let us take a very simple and straightforward process. The production engineer is called upon to finish a cylinder bore. You can finish it by grinding, you can bore, using high-duty alloy tools, ream, roll or hone it. It ought to be possible to say definitely that one of these processes is the best—the standard process for doing a simple job like that. Many production engineers will tell you that every one of the processes I have outlined is far away the best of the lot. I may endeavour to tell you later why some of them are not. We can obtain the best results from process standardisation by close co-operation between members of this Institution. You cannot compile permanent lists of standards, you must keep on revising them. It sounds paradoxical but it is not really strange. Standards should be kept abreast of progress. Above all, we must go out and sell their use to the people who should be using them. By doing these things we shall have done all possible to render a real service.

Part VI—IS IT POSSIBLE TO FORECAST LINES OF ACTION FOR THE FUTURE OF STANDARDISATION? By S. Carlton Smith, M.I.P.E., Chairman of Council and Section President.

I HAVE apparently a *totally* different side of the question to open up to any of the others—that of forecast or of prophecy. This aspect of the case sounds so nebulous. Production engineers are accustomed to dealing with and giving known facts, but I wish to endeavour to show that just as the production engineer is required to foretell with considerable accuracy what his production in the future will be, because that forecast is based on certain data, so will the application of known facts enable us to foretell with a certain amount of accuracy the future of less concrete subjects, such as our present one, the future of standardisation.

The future is always difficult to forecast, but if we are to have efficient standardisation we must look as far into the future as we possibly can with a view to stabilising or standardising designs for as long a period as is possible without cramping progress. Whilst it is difficult to forecast that future, full and free discussion on possible lines of development will undoubtedly clarify ideas as to what standardisation appears to be possible. Without a look into the future, standardisation will be cramped and inefficient.

It is bad composition, besides being redundant, to repeat a word, but I do sincerely wish to emphasise that prophecy is apparently a *totally* different aspect of the subject to our other considerations, because forecasting or prophecy has always been associated with the occult. But occult is only a word given to knowledge where our knowledge ceases. We have all read of the prophets of old, and prophecy seems to be a lost art. Not a bit of it! It has gone on all through the ages, although intermittently with outstanding examples, but industrial forecasting is an established science to-day, and progressive firms have forecast departments.

Looking back through history, Isaiah was one of the greatest prophets. Such men had minds that were stores of wisdom; they were readers of the chronicles and students of human nature; their minds were receptive to the sources of infinite knowledge. Skipping through the ages, a notable example in the middle ages in England was Mother Shipton. She is reputed to have foretold the invention of: horseless carriages (the modern motor car was so-named when first introduced); the electric telegraph; the steam engine; that

engines would fly in the air ; that ships with engines would swim under the sea. Her name first appears in a pamphlet dated 1641.

Now, in ancient times the great prophets were leaders of men who were so far above the common mass that they commanded great respect. In the middle ages when the masses were gaining that " little knowledge which is a dangerous thing " they were treated with contempt, born of fear, and moreover with persecution, being regarded as occult and in league with Satan. They were thrown in ponds, as a test, to sink if they were wicked, to float if they were good, but nevertheless as an afterthought to be beaten or burned if they did float.

In these enlightened times, in which we are so fortunate to live, it is recognised that if we study previous rates of progress, previous setbacks and accelerations, modern tendencies, the influence of fashions, the factors and influence of individuality, of co-operation, of joint associations and boards, of government and parliamentary changes, the trend of legislation, of popular attitude and feeling, of rationalisation, the strides of education, there is not the slightest doubt that the collection and application of this knowledge will enable us to determine with greater accuracy than could have been imagined what the future of standardisation will be. In general, standardisation will go on, in every direction that is to the benefit of industry and to mankind. It will only cease before the point of monotony or cramping individuality, or where different conditions demand variations to standard.

The *rate* at which it will progress is more difficult to forecast, but it depends on the ability of all to recognise its advantages, the *will* of all to further its developments and to make sacrifices on non-standards and old standards to come up to newer and higher standards.

The rate of progress depends, curiously enough, on the interchange of ideas. Because England is isolated by water from the Continent, we have the foot standard, and the Continent has the metric system. We drive on the left-hand side of the road, they drive on the right More curiously, perhaps, the rate of progress depends on international friendship.

If we are asked a concrete question such as : "Can we halve the number of different models of cars we have to put through ? " the reasoning to arrive at the answer is on the following lines : The question is linked up with, " What progress will be made in industrial understanding ? " " Shall we adopt the metric system ? " " Shall we drive on the right-hand side of the road ? " The metric system is admittedly more convenient and the question of its adoption has come up many times at intervals, and last time stood a good chance, but old standards and prejudices won, because of the far-reaching

effects of a change which would effect even village grocer shops. Probably not for a long time yet, but ultimately, there may be one standard of measurement.

With regard to driving on the same side of the road, as the rate of interchange of international thought and understanding continues, international trade will increase. As international trade increases so will the demand for channel tunnels *or even bridges* continue. When there is road communication with the Continent, or even fast ferries by water or by air, the vehicles conveyed will ultimately become sufficiently numerous for legislation to direct driving on the same side of the road on both sides of the channel to prevent confusion and accidents—the very reason why now it is feared to make the change. Then vehicles will all be either right or left-hand drive, and the number of standards will be halved. And so on in many other ways, this reasoning being given purely as an illustration.

Standardisation will never go far with things that depend on physical conditions, individual tastes or fashions. The size of jam-jars, for example, will never be reduced to one size while families are of different sizes and lots of people live in hotels. But so long as we are on the lb. weight standard, they will be limited to the 1-lb. size, 2-lb. size, and so on.

The foregoing are merely lines of thought. Time does not permit detailed illustration in regard to the future of pulleys, couplings, bolts, nuts, etc., but the same process of reasoning and using the factors affecting all standardised articles applies. That is why I referred to roads and also to jampots.

In conclusion, may I read a newspaper advertisement ? :—

" *Wanted, a caretaker*. His wages are to be £2 a week, and, in addition to his caretaking duties, he is expected to : Cultivate the garden ; supply vegetables and flowers in season when required ; cut the grass ; keep the gardens, grounds, and walks neat and tidy ; maintain and repair the motor ; take charge of clothing ; stoke the furnace ; carry coal and dispose of ashes ; chop firewood ; clean the windows ; and, in his spare time (laughter), he is to make himself generally useful ! "

The production engineer must not only have a knowledge of machines and tools, but of materials, of management, organisation, costs, wage systems, psychology, and now to his duties are to be added forecasting ! And, if he has any spare time, it is expected of him that he will make himself generally useful.

Discussion.

MR. J. S. REED (Member): After listening to the excellent papers read by the six lecturers this evening, one wonders if it is generally realised what a colossal field standardisation could and does cover. Regarding the aspect of the subject mentioned by the first speaker, Mr. Wright, and from a general point of view, I think one must admit that standardisation is more or less forced upon us by the manufacture of common necessities of life providing for the large mass and increasing population over the whole world. Engineers are in a great measure responsible for the creation of these standards because they are the inventors and manufacturers of the machines whereby these products are made rapidly and economically. I am sure that the second speaker, Mr. Allan, was correct when he said that engineers generally knew very little regarding standardisation and the standards which were at present in existence. They do not make a practice of standardising parts or tools, consequently many a part is designed when an existing part would do, with perhaps a slight modification, thus saving largely on new work. We engineers can do a great deal in the field of standards, not so much individually as collectively. However, standardisation should not be allowed to deter the inventor or designer who may have some really good idea and who, because of an existing standard, would be disinclined to bring forward something new and good.

MR. BROOKE: I personally, do not think that standardisation will ever deter the inventor or designer of machine tools. Referring to Mr. Bedford's lecture, he mentioned very briefly the question of sub-contracts in war time for the Government. I think that the Government were in a very trying predicament as regards standardisation. When war broke out there was no standard drawing available for any part of even a British rifle. Standardisation! How on earth we got over the difficulties goodness knows! It was realised that drawings had got to be prepared for getting down to the threads, as there had been no demand whatever in the past by the Government to standardise. Threads were any measurements. I remember a thread 26. 1/3 T.P.I. This was neither Whitworth nor B.S.F. nor B.A. A gauge was made for future reference, and the Government eventually got over their difficulties. You got a bigger radius at the top of the thread than at the bottom. You can quite understand the difficulties that arose in sending out work for contracts. This goes to show the vital need for standardisation. In the unhappy event of another war there would not be that difficulty again. Referring to

drawings ; at one firm I was with, a data sheet was issued and the dimensions marked high or low $\frac{(H)}{(L)}$ and such dimensions had to be complied with, and all work outside these tolerances was scrapped. Tolerances can be worked to. All dimensioning has not yet been standardised, and, of course, this point is open for a lot of discussion. Something can be done with a view to standardising drawings, even throughout the works. My third point is sub-contracting as it occurs to-day. Take certain parts required which are not manufactured by the firms themselves ; ball bearings and things like them, for instance. The contracting firms to-day are, no doubt, in a very difficult position. There are so many designs and makes on the market. Alterations to design quite often upset the designer and it sometimes means redesigning the unit. It is an improvement to standardise the parts which are sub-contracted.

Mr. D. M. King (Associate Member) : We have heard a lot about standardisation to-night, but there is one point which nobody has touched upon and that is how to standardise the buildings where these processes take place. Some processes and machines are carried out and worked in buildings that are totally unsuitable. I think that production engineers are, firstly, concerned with the type of building in which they are going to manufacture. Such things as width and height of doors, for instance. When visiting a works recently, the managing director took me to a machine 10 feet high and said that he wanted to move it and that that meant getting it through a seven foot doorway ! This is helpful to the production engineer ! One of the first things to consider is the building and all construction appertaining to it.

Mr. Ault (Member) : I, like previous speakers, wish to have a " go " at drawings. You get plenty of information on it but it is not large enough to read.—(Laughter). No drawings should be issued with any letters or figures less than $\frac{3}{32}$-in. in height. The average man in the shop does not get a chance to standardise. I would invite our committee to approach the council and ask if data sheets of standards could be inserted in *The Bulletin*, say, at least one every month. With regard to advantages or disadvantages, either you do or you do not take sufficient advantage of existing standardisation, which has covered all sorts of things for the last twenty years at least. Such things as pipes, rubber tubing, gas fittings, electric fittings, etc., are standardised and we do not appreciate their full extent. Referring to Mr. Gilbert and his spindle nose (Laughter)—on the blackboard I mean (Laughter)—if any firm has got money to spend and they ask for a special spindle they get it. Many machine tool manufacturers are only too eager to supply what you ask for, if you only go to the trouble of asking. The other point

is electric motors. You mentioned the different types of winding, different coils, etc., these can be very well improved I think. One point about machine tool designing. I do not think that machine tool builders should be too popular. If you are using No. 2 morse drills the buyer should not buy machines that won't take No. 2 morse. Personally, I am all out for standardisation.

MR. GILBERT: Talking of Mr. Ault's remarks on my spindle nose, lots of things have been said about my nose at different times, usually for putting it where it is not wanted.—(Laughter). As regards machine tool suppliers falling over one another to give the production engineer what he wants, we bought a machine from America and we were particularly anxious to develop a British source of supply. We showed a British manufacturer the machine and told him what we wanted. After waiting four weeks we eventually took a draughtsman and made some drawings, complete with dimensions and limits, and sent him all the drawings. After further considerable persuasion and a firm order for eight machines, we actually got in a price. When we got it we found, to our great amazement, that the price was equal to the U.S.A. one. After still further persuasion we did get the first machine tool. They photographed it and sold eight on the strength of the photograph. That the machine tool builder is anxious to provide the production engineer with every tool he wants is a little overdrawn. The colour of paint has not been drawn out in the discussion. Something would be achieved if we could standardise even one, so as to get the multitudinous shades and tints served up on us to conform to a given description. Again, do production engineers sufficiently realise the saving in lighting cost and the gain in efficiency obtained by painting the underside of roofs white? Referring to No. 2 morse drills, thereagain the production engineer buys the best machine. Regarding Mr. King's remarks on the standardisation of buildings, the production engineer usually does give some consideration to the height of doors and floor space. By putting two feet on the width of a door one can save hundreds of pounds a year on damaged vehicles.

MR. PUDGE: Mr. Gilbert said something about boring the cylinder. I should like him to tell me if he does agree with boring, grinding, and finally honing, as the agreed, best, and standardised way of machining a cylinder?

MR. GILBERT: I will endeavour to answer that question, Mr. Pudge, if I may make further use of the blackboard. You are referring to all the known methods of boring, reaming, rolling, and honing? We will take something I am familiar with, a cylinder of an automobile. You have, generally speaking, three things to consider. Quality, cost of manufacture, and rate of manufacture. First of all quality. There again I think you can sub-head again

dimensional and finish. Want of accuracy will give, on the one limit, piston slap, and on the other limit a possibility of seizure. Bad surface finish of the work might also cause seizure. Speed of manufacture is absolutely essential in these days, getting down to the minimum possible price. Take any maker whether charging £3,000 or £150 for a car, the speed of production is just as important. Take this casting (*demonstrating on blackboard*) and proceed to remove the rough stock as rapidly as possible. Then let the casting have a respite during some minor operations. Then I would take the casting and again bore it. My reason for that is because reaming is one of the finishing processes. I would, therefore, do that in order that I may ream square with the crank shaft axis. It is a cheaper method of removing a lot of stock than honing, which is the final process to give me the accurate grade of finish which I desire. You get away from one or two troubles for one thing. If you rely on reaming and rolling processes you never get a cylinder parallel—you get a rib at the bottom adjacent to the flange of the water jacket. Take the rolling process first. If you rely on the rolling process for sizing, your weaker section here and there will open out and spring away from the rolling. The same applies to the reaming. Reamers are not invariably operated sharp, they are often operated blunt. Consider the boring bar of several machines. Your bar advances from your bearings. I would not expect to produce a parallel bore off a spindle like that. Then again you are up against a certain amount of reaction on your spindle bearings. You can produce a bar that is fundamentally more accurate. When you finally ream and hone I think there is this point to be said for it. Your first job is to rough-stock out very quickly. I have seen a cylinder block, with a bore 8½ inches long, put in the machine and back on the floor well under three minutes. You then come to the second operation, trueing the bore up, for which the single pointed tool still remains the most reliable method. You are still proceeding to remove the stock as rapidly as possible consistent with the trueing operation. Next, you put through a reamer which has its blades alternatively right-hand and left-hand, with front and rear running pilots. By the use of front and rear pilots you obtain a parallel hole and help to eliminate chatter. By honing you attain the final finish which is infinitely superior to that obtained by a reamer. The combined taper and ovality can be held to .001 inch.

MR. PUDGE: What allowance would you leave for final honing?

MR. GILBERT: About .0015 to .002 inch. One particular point in honing is to be most extremely careful in filtering the paraffin.

MR. PUDGE: The grinding operation to my mind is not wasted. We rough bore and finish bore with two shell reamers, both fluted,

and this should cut out the honing operation, by getting the finish from the grinding operation. Do you really think that honing supersedes grinding, or that grinding is not as good as honing as an operation to-day?

MR. J. D. SCAIFE (Member of Council): I look upon this evening as a very fortunate occasion on which to be in Luton listening to these interesting papers. To have six speakers is very wise. Leaving the subject to one speaker you do not get the advantage of so many minds each dealing thoroughly with different aspects of the subject. I believe that Council will be very pleased at your method and treatment of the subject which has many angles. With six different speakers you do get a very wide vision. There are one or two points I would like to mention in regard to standardisation. Screws, keys, spanners, etc., are standardised, but you do not get the material standardised to the same extent. One of the greatest needs for standardisation is standard tensiles in screws and spanners. I have found great difficulty in interchanging electric motors. Quite big changes in design are necessary in machine tools to accommodate various motors. Standardisation is a subject which can very easily be overdone. I should be one of the first to kick against too much restriction upon individuality and progress. Mentioning again that nose of Mr. Gilbert's, whose chuck is it going to fit? You can make a plate to accommodate anybody's chuck. Another point is—how far can standardisation go? Referring to Mr. Henry Ford, I think he carried standardisation too far. Standardise only the definite things which are needed. We want standardisation of details, perhaps units of our machines, such as pipes and other various components. We have lots of ideas to cheapen things. Standardisation, as Mr. Bedford said, helps to cheapen things, but do not let us lose efficiency.

MR. REED: Mr. Scaife has emphasised the interference of standardisation upon the designer and that I think would and does happen. There is no doubt, to my mind, that the question of standardisation does, in a measure, hold back progress and the development of individuality and originality. Referring to Mr. King's mention of larger doors, the production engineer often does not have much to do with the building when it is constructed. The building, and sometimes the machines in it, are there, and he is expected to get the work out of it.

MR. ALLAN: I would suggest that the production engineers do not know enough about standardisation already in existence, and that they might draft out a paper containing a list of those specifications standardised by the British Standards Institution. But the British Standards Institution has no standardisation as regards

limits and tolerances. I do not think that in that way they yet cover all the needs of industry.

MR. G. F. FARR (Member): I have been an engineer for forty years, and we have advanced in these years. I wonder whether we shall take standardisation too far. In every branch of engineering there are many machines. The maker has 200 different types of machines for the hat which one wears. A glove is made on very similar machines as a hat, but not one machine suitable for making a hat will make a glove. I have used standardisation but, generally speaking, there is a tendency in engineering to take it too far. Unless we bear in mind that standardisation may go too far we shall lose that leading position as engineers. Certainly I think we do want standardisation in material and threads.

MR. SCAIFE: I should like to hear some discussion in regard to standardisation of measurements and limits and to hear if anybody present has any experience of the unilateral system so largely used on the Continent.

MR. ALLAN: I am afraid that after the long discussion this subject may prolong the evening too far and at your discretion had better be left for the next occasion.

MR. THOMAS: We have heard a lot about standardisation, but what about patents? Until fourteen years have passed I do not think anyone can touch a particular design or apparatus, otherwise what would be the use of patenting? Patents are a drawback to the standardisation of such things as gear boxes, etc. We know that even in Luton, there are motor firms who might like to adopt the fluid flywheel. Standardisation of patented articles may not always be economical because you have to pay royalty.

A VISITOR: First of all, I should like to congratulate this Section on the success of this meeting to-night. In reply to Mr. Gilbert's experience, I am of the opinion that there will always be a demand for special plant and special fittings which depend on the purchaser's requirements. Standardisation and mass production are in many cases synonymous terms. Standardisation can be blindly followed to a degree that prevents progress and adaptability and is even regarded as a slow poisoning, but standardisation need not prevent specials of anything being made if profitable. Standardisation is useful when applied to the regularising of the number of sizes and dimensions of manufactured articles, in order to reduce the production costs to a minimum, without loss of efficiency or effectiveness of the article in any way. It might assist in stabilising markets if standardisation could be applied to the known values of materials and labour, and to define the duties of the various departments in a works (design, manufacture, production, progress, and so on)

so as to prevent overlapping of duties but to ensure linking up. Standardised methods are needed in the offices and in the works, to define the actual methods of production and also the material used in production.

MR. S. CARLTON SMITH : Gentlemen, I now draw the meeting to a close. I am afraid that I cannot call upon any one for a vote of thanks as we are all criminals together.—(Laughter).

STANDARDISATION AS APPLIED TO PRODUCTION ENGINEERING.

Five Short Papers presented to the Institution, Coventry Section.

Paper on STANDARDISATION; WHAT DOES THIS MEAN? and WHAT ARE THE FUNDAMENTALS OF STANDARDISATION? by R. B. Cole, M.I.P.E.

I HAVE been invited by the Coventry committee to expound my views under these two headings. In attempting to do so, I fully appreciate that the second of these two headings is the "kernel" of the subject we are here to discuss to-night, as it is obvious that we must first endeavour to form some very definite opinions on the broad outlines on which "Standardisation" is based, and afterwards agree that these principles are sound before we reach the stage when our keenness calls out for further development and a broader application. It is therefore with diffidence that I venture to state my views on this very important aspect of the discussion, realising that there are many here who have given these matters much keener consideration than myself.

I should be glad if you will consider the points I am about to make, as "feelers," just to draw from this meeting other and more important items of common interest which have in all probability been omitted.

Taking the first heading—"Standardisation—What does this mean?" I would say that the fundamental principle underlying standardisation is: "the will to establish a common standard for any article which has a common purpose, or interest." This "will" to establish common standards has led us along various lines which may roughly be summarised as follows: (*a*) Those which have been designed for public convenience—as for instance "standards of measurement." (*b*) Those which have been designed for general industrial purposes—as for instance "railway tracks." (*c*) Those which have been designed for internal convenience—as for instance, "the uniformity of materials for machining, chuck adaptors, etc." Other speakers will deal with these various phases in detail, so I will now pass on to the second main heading, "What are the fundamentals of standardisation?"

First of all I intend going a little beyond the scope of the heading which has been chosen for me, and will subdivide my remarks under three groups, as follows: (1) Standardisation as it affects our country; (2) Standardisation as it affects the public; (3) Standardisation as it affects the engineer.

(1) Standardisation as it affects our country.

It is my opinion that a more complete national understanding and a broader application of the principles of standardisation would lead to a greater prosperity in the various engineering industries of this country. My assertion that a broader application of standardisation would lead to a greater prosperity, is based on the belief that any move which increases interchangeability of parts, which reduces production costs, and which leads to a better understanding with the "purchaser," must inevitably bring a greater volume of trade.

If this is agreed upon generally, it follows that, with such a laudable objective in view, every effort should be made by all engineering institutions in this country, and the Institution of Production Engineers in particular, to collect such a mass of facts and important data together, as will convince the engineering community to press for something more tangible that has hitherto been the case.

The first and most important fundamental to my mind is therefore, "co-operation of ideas and effort, to assist in forming a sound basis for future national endeavours."

In making these remarks I am not unmindful of the wonderful work which has already been accomplished—for instance by the British Engineering Standards Association, but it is the application of the available information where, in my view, we have fallen far short of what might have been accomplished. This is not the fault of those gentlemen who have given every thought and endeavour to this subject, but to the various other institutions and the engineering firms in particular, who have failed to get together for the common good of all.

Our own Council probably had these sentiments in mind when they instructed all sections to reserve one evening to discuss "Standardisation," and I have no doubt that when the mass of detail emanating from the various sections has been sifted, the result will form a sound basis for a first move in the direction I have indicated.

(2) Standardisation as it affects the public.

It is very true to say that any effort which is not designed "to serve," cannot in the end succeed. Here we have a subject in which the public is intensely interested, the public are interested from many points of view, amongst which are—quality, value, and service. Look what the public has to gain. In the first place the

trader would be very satisfied, that if through a broader application of standardisation, he could reduce the variety of his stocks ; and the reaction to this would be to allow him to render more rapid and efficient service to the public.

It is obvious also that there is greater concentration from a manufacturing point of view, whether it be on complete units or individual items, and which have been standardised—leading to cheaper production, and the passing on of a proportion of the benefit which accrues, to the public. The public would also assuredly welcome greater interchangeability—for instance, we in the motor industry can appreciate the public's point of view, in these days of rapidly changing design.

As an instance to illustrate my point, I would mention a certain local manufacturer supply tappet heads, so many different varieties and sizes are made, that the difference is not discernible to the eye, and each one has to be specially marked in order to avoid confusion. This is a simple instance, where the public could benefit, providing definite aims and lines of action were more clearly defined.

(3) Standardisation as it affects the engineer.

I know, that in expressing my views under this heading, breakers lie ahead. The position can roughly be summarised under two headings : (*a*) the designer ; (*b*) the production engineer.

It is natural that the designer does not in many cases see eye to eye with the production man on this subject—he is apt to resent efforts which tend to put the brake on his fertile brain, and which restrict his tendency to produce beautiful designs.

There is of course, much to be said on the designer's behalf in this connection, however, as I feel that the reasons for a wider outlook far outweigh those against, I will leave those designers who are with us to-night to keep their own end up, in the discussion which will follow, providing our chairman bears with me and is ready to answer their questions.

However, there are many lines of thought and possible action, on which the designer and the production engineer, do I am sure, agree. For instance, the designer who has to do with splines and spline fits, material specifications and the thousands of irritating points which should be common knowledge, and become common practice, would welcome (with the production engineer) a more definite lead by the various associations and employers alike. It is only fair to say that the S.M.M.T. and I.A.E. have already in operation, standard recommendations in loose leaf form of much merit. The production engineer and the operator in the shops, would, without doubt, welcome a concentrated effort to relieve him of his many troubles.

Where budget allowances and economies in every direction are an every day watchword, the application of standardisation has a very

definite meaning for those concerned. The various avenues for economy are manifold, and as later speakers will be dealing in detail with these, there is not need for me to further stress this point.

I would just like to mention one important matter which I feel would be a lasting benefit to the engineer, that is, that I am convinced that the metric standard of measurement will have to come in this country sooner or later, to the exclusion of the " mixed grill " which we now have. It is admittedly simpler in every way, and above all would lead to a better understanding with our foreign customers. That we should first have to count the cost of a definite change-over is certain, but no doubt lines of demarcation could be laid down, and a gradual but definite commencement made in certain directions.

As Mr. Griffiths is about to deal with, in detail, the standardisation that has already been accomplished, I will conclude by summing up the position as I see it.

If we are agreed on an intensity of effort to make standardisation a real live force so as to benefit the country, the public and the engineer, surely a national central body, or a central body for each industry working in conjunction with the various associations and the manufacturers' associations, can lay down sufficient agreed data, and distribute this information in such a manner that it will be available, and indeed vitally necessary to all engineering staffs.

Paper on ARE PRODUCTION ENGINEERS SUFFICIENTLY FAMILIAR WITH THE STANDARDISATION THAT HAS ALREADY BEEN ACCOMPLISHED? by J. W. Griffiths, A.M.I.P.E.

THE method of presentation of the subject under discussion to-night has certain inherent difficulties which prompt me to apologise beforehand to my colleagues, if I have unwittingly traversed their territory, and urge that the blame be visited upon those responsible for the sub-division.

My task of answering the question: "Are production engineers sufficiently familiar with such standardisation as has already been accomplished," therefore, relegates me, I fear, merely to an analysis of the relation of standardisation to the production engineer.

At the outset I would like to commence the answering of this question, with a further question. Is it a fact that progress towards standardisation has been slow, due to the fact that it has no natural basis? Because it is only during the later stages of the present industrial era that real serious strides have been made in this direction, and I believe that the 1914 war was the first occasion that belligerent nations were using interchangeable armament enabling captured equipment to be used for more sinister purposes than just decorating the village green or pond as the case may be. Maybe the answer to that is that consideration had to be shown to the neutral armament supplier.

Many instances come to my mind illustrating the fact that the Creator had far more interest in craftsmanship than interchangeability, and whether one looks for botanical, biological, zoological or geological instances, except in such instances chemical and atomic structures and time, that nature seemed to abhor a standard.

I was somewhat amused to note that the American counterpart of our Standards Bureau had been asked to standardise the egg carton, but I looked in vain for a meeting of a sub-committee of the 100 per cent. American hen to see what they were going to do about standardising the product to put in it. Even the human race does not show any real love for a standardised product. The builder builds standard houses for someone else to live in; the new tailor makes standard suits for someone else to wear, and with bated breath I suggest that the manufacturer of standardised motor cars does not often show too great a partiality to ride in them. You remember Henry Ford said he preferred a Rolls-Royce because it was the world's second best. You may have also heard murmurs of the

desecration of Trafalgar Square in sticking standard robot lights all over the place.

There is a point of cleavage where internal manufacturing convenience must give place to expression of individuality, or if you prefer the term "craftsmanship" and determine irrespective of merit the application of a standard crudely expressed, one would be a fool not to standardise the bayonet joint or a lamp bulb, but it becomes an outrage to the aesthetic to standardise the lamp post.

Generally speaking, terms of expression, such as drawings, tolerances, nomenclature and tool equipment, are the outstanding items which arise to the mind of the production engineer; then in lesser degree material specifications, screw thread forms with tapping clearances, spanner sizes and recognised colour charts are thought of, and yet one finds that there are many others which are instinctively at the back of the mind, too obvious to be at first noted. Taper shanks, drill and reamer lengths, standard gauges, relation of hardness to machineability, cutting angles, etc., all come under the heading of internal conveniences.

From the design angle, the growth of the use of proprietary articles has been the greatest propagandist for standardisation. Very few motor car manufacturers would to-day set out to make steering wheels, magnetos or dynamos, so that the common aim of purchasing these articles at the lowest figure means that they must be accepted and accommodated for as near as possible to the maker's standard product. Tyres, inflators, rims have had to be standardised, and the foregoing remarks apply to the efforts to standardise wheel bolt centres and even wheel nuts and braces. The latter point is better appreciated when one has a puncture on the road and remembers the wheel brace is in the garage, and tries stopping other motorists for the use of theirs.

Before the war period, despite the existence of certain standards laid down by the Institute of Cycle Engineers C.E.I., it used to be the practice of the different cycle manufacturers to deliberately depart by a few thousandths from these standards. I still remember sizes such as .140 × 40, 162 × 32, 196 × 32, 510 × 20; anything but the size which people like Halford were selling standard nuts for, until two things happened. Firstly, the general public got fed up at having to pay often at least twice as much for the maker's special article, and secondly, the manufacturer found that if he was to meet the demand for a very much cheaper bicycle he would be compelled to standardise such things as pedals, freewheels, crank bearings, hubs, all of which he could buy complete for little more than his previous material cost, and of course, this applies equally to the bridge builder with his standardised girders, fish plates, etc., or the shipbuilder or the boilermaker, or the machine tool builder. The object of the designer must ever be the maintenance of quality and

individuality with the incorporation of as much standardised equipment as is compatible with his requirements.

Therefore, I picture the production engineer more with a watching or grumbling brief, being mainly the sufferer or victim of lack of standardisation. How often does he find that in a complicated component the draughtsman just seems to have varied the size of hole or facing to save the fitter having to use the same size of spanner too long.

I feel that I cannot leave the question without some reference to the service which production engineers often get. One buys a standard machine—say, a small turret lathe with which a certain amount of standard equipment arrives, but not quite enough for the job in mind. You decide you would like to use, say, a collapsible tap, so reference to the maker's catalogue shows the desired object with a type to suit the machine you have brought. You place your order, stipulating a perfectly common, in fact, almost universally used pitch of thread, but much to your surprise you are thanked for the order, with an intimation that subject to fires, strikes, earthquakes and other acts of God or man, that in ten to twelve days your tap will be forthcoming. You curse and wait, and at last it comes, but the trouble is not over yet; it won't fit the turret. You ring up the supplier—"Oh!" he answers, "that's all right, you just want a *special* adapter to make our standard tap holder fit our standard turret." Many of you will be reminded of similar experiences.

Production engineers are fully aware of existing standards, and I believe in the near future knowledge which will enable them to compel machine tool makers to come in line with the small suppliers who are springing up, able to give better service at much lower cost in the matter of equipment, than we have previously had, for at present it is often cheaper to make the job in your own tool room than endeavour to buy standard equipment of this nature.

I would like to give one instance illustrating my contention that standardisation is instructive with production engineers. About 1913 I got a job as jig and tool designer at a firm building fairly large Diesel turbine and steam engines, and after motor cycle work I felt a bit worried about the sort of box jig that would be used on, say, a turbine body, but I had no need to worry. The card index was a far more important feature than the drawing board; actually, certain major features of these engines were so standardised that on receipt of prints a few hours' reference to index had supplied practically all the jigs needed for the job. A certain size of crank almost invariably carried a standard flywheel size flange with standard bolt centre pitch, so that it was just a matter of turning up the jig which had the necessary spigot and recess on reverse faces for crank and flywheel. The jig had standard liners and again from card index suitable drill bushes

were looked up. The same thing applied to rectangular flanges ; the pitch line determined the number and size of bolts. A 12-in. × 8-in. rectangular flange would be found to have, say, 12 $\frac{3}{8}$-in. bolts, and the necessary tapping and clearance hole bushes were turned up to suit adapters to bring that machine into line with his standard locations for jigs and fixtures.

Lathes and milling machines are still made with screwed spindle ends, which on production work are very rarely used. Some may say that the centre lathe itself is no longer a production tool, but in many establishments it still plays a very important rôle, which draws attention to the standardisation of spindle bores. Again, these are all standardised, but there are still such a frightful lot of standards. A tour around the tool stores will surprise many people at the variety of stocks of such things as grinding wheels of all kinds. Tool grinding wheels, production external and internal wheels, each different make of machine requiring a separate stock of milling fixtures will be noted with loose tenons so that amongst other reasons the variety of machine table tenon slots may be catered for, but I must submit that the evolution from this state is coming as a result of commonsense on the part of the production engineer, rather than any studying of the findings of Standards Bureau, because when new plant is being purchased a greater interest is shown in such features. One rarely finds a popular machine nowadays where hand-wheels do not turn clockwise for a forward motion and vice versa, or traverse levers go forward for a forward operation of the slide.

It may be unfair upon the advocates of the B. and S. standards of taper shanks, but the " flowers that bloom in the spring " would certainly be more welcome than a new design of drilling machine with a B.S. taper in the spindle, in fact, it is time that taper shanks had gone altogether from this type of tool.

My only object in mentioning this is to show you that where policy allows the production department the necessary power, standardisation takes care of itself.

Paper on CAN STANDARDS ASSIST THE PRODUCTION ENGINEER, AND IF SO WHAT SHOULD BE STANDARDISED? By J. A. Boyes, M.I.P.E. (Member of Council).

I HAVE confined myself to one section of the engineering factory, and whilst you may think I have got a "bee in my bonnet" I only take up this side, feeling sure that the other speakers will have dealt largely with the other sections.

Brief mention has been made of the S.M.M.T. electrical standards, and B.E.S.A. standards, and the first part of this query is really answered by past performances of which you are mostly well acquainted. In whatever branch of engineering or commerce we consider, we can find that standardisation and standards have proved of great benefit.

Starting from the designer's point of view with his B.E.S.A. specifications, he has received great assistance—sometimes with caution, sometimes with great glee—in producing his designs, giving him the various weights, limits, and materials which have been standardised. After he has obtained his first designs on similar lines, he can build up standard sets of equipment, etc., which will greatly assist in future. This may become an internal works standard for the guidance of other departments generally. The designer can be of great help to the purchasing department in placing orders, thereby obtaining supplies of material at an economical purchase price.

On to the stores. Stocks can be maintained more readily with lower capital expenditure, the depreciation account can be reduced, there is greater ease for the transfer from one design to a new design, giving easier checking of stores.

In the tool room we can more readily maintain standard jigs, fixtures, and gauges, which has been very clearly proved by the previous speaker. At the same time this department can concentrate on greater accuracy and refinement where necessary, and bring in a lower and more economical cost to that department. Standardising of jigs and details by the drawing office will assist both the tool room and the production engineer.

All the aforementioned will have a great bearing on the production department. It is the duty of the production engineer to consolidate the duties of his own department through the several departments who have to use these standards. In such a manner an internal work standard becomes a very important matter to each set of shops. The production engineer is able to stabilise his production. Costs

can often be reduced, the unit cost can be more readily obtained and also reduced, and a greater saving of material and operations can be maintained.

There is the uniform running of plant capacity, giving better service to workmen and product. Greater attention can be given to the improvement and accuracy of plant and product, reducing to a large extent possible errors in the inspection department.

Lastly, sales, which are really the final idea of production. The sales department can more readily catalogue their goods and possibly reduce selling prices, which in turn may obtain repeat orders for both new articles, renewals, and spares. More productive publicity can be given to a standard article.

A catalogue full of varieties remind you of the daily paper. From the sales department the storage can be greatly reduced and a large improvement in packing and transit conditions will be obtained.

In regard to the second portion of the item—"What shall be standardised?" Mr. Drane and Mr. Cole mentioned about the classes of standardisation. The foundation of the B.E.S.A. Institute laid down two classes—one was the fundamental standards and the other the industrial standards. It is industrial standards we have to deal with chiefly. The fundamentals which are all of national and international concern, are therefore left more to the public body than to a section.

What shall be standardised? There are many instances of existing standardised parts, both internal and external. It has been suggested that standardisation holds back design, also causes stagnation, and it has also been said that it produces monotony both in the works and outside.

I will not trespass too much on the designer's sacred sanctum. Progress advances on unorthodox lines, but standardisation takes place when an article is produced. May I step into the drawing office and suggest that the designer clearly informs, through his own a.b.c. of drawings, what he wishes the production engineer to understand accurately; also to convey his ideas to the sub-contractor who may know nothing of the particular firm's drawing office habits. I refer, in the first place, to the principle of drawings, where in the first or third angle projection, known as the English and American methods respectively. Both have several advantages, and in fact, I believe both are used in some drawing offices. When the drawings come down into the workshop, many of the operators are not altogether familiar or quick at reading from a drawing which view shall be taken, and in which direction the view has been drawn. In many cases, from reading an American design of drawing, errors have occurred and work has had to be destroyed.

Can we define some system whereby the selected type is distinctly shown on the drawing?

Then there is the naming of drawings showing schedules and details, and charts which would be very helpful for detailing as well as reading off, and some scheme be fixed, say the right hand bottom portion to be used specifically for detail naming, such as the job, tooling, operation, and other details as regards the drawing itself.

As regards dimensioning on the drawing itself, dimensions have caused trouble in both works and drawing office. Whilst drawing offices have their own systems, with constant changing of employers, contractors, and draughtsmen we get dimensions placed in various positions from single drawing offices.

May I suggest that in the small dimensions on our drawings, say under 10 ft. lengths and three metre lengths, it might be possible for us to comply with the reading of all measurements under 10-ft. ; for instance, in our blue prints and drawings they are not always very clearly defined. Take, say, 8′ 1″. If the work is rather cramped, the 8 and the 1 get very close together, the dash becomes almost a dot, and the two dots over the 1 become so indistinct that it can be read as 8.1 ft., 97″ would be more clear. I once saw on a drawing 1 ft. 0.5″. It occurred to me at once that this could be easily read for 10 ft. .5, or 1.05 ft. In a case like that 12.5″ would be much more clearly defined. These are just suggestions that I make for your consideration.

In addition to the metric system being suggested or pressed for adoption in this country, may I also add the centigrade scale of temperatures for our general workshop service ?

Can we abolish the blue print ? In regard to drawings, blue prints, etc., for general service, why not have a standardised size for sheets or mountings which would greatly assist storing, tabulating, etc., in the shops, stores, tool room, and office ? We find that in the works and stores men are handling various sizes and much time is lost.

In the naming of materials on drawings, is it possible to establish a more definite symbol than as recommended and adopted in some cases ? Let us go to the broader view of standardisation. The designer sends to the drawing office his ideas to be put into lines and figures for the purpose of showing the producer what he wants. All our services are equal, whether it is in the design, production or sales. The idea is to turn over cash to provide work and supplies.

The outside contractor requires guidance of the designer's ideas, therefore, simplicity of details, arrangements, views, and information should be realised. A closer union and intercourse between the drawing office and the production engineer would help to standardise much and reduce common errors.

Whilst standardisation on machine and tools is developing slowly, much can be done in the works. Through the production engineer we can gain much.

B.E.S.A. have already provided 500 specifications. May I ask " Is the production engineer making use of these advantages ? "

A further suggestion as regards gauges which we have to deal with. There are about 15 gauges for use on different materials—some for brass, copper, iron, and various metals, and also some are used for plate sheet and wire, etc. An advantage would be to have one standard to deal with all metals.

Whilst screw threads have been standardised to a large extent, a great deal of trouble occurs when we get the American and English screws mixed on a machine, and there I think some movement could be made as regards standardisation.

There is still trouble with the right and left hand thread. For the guidance of the operator, a right hand thread should have some indication of its type.

The indication of finish on drawings could be more clearly defined than we have generally accepted. Jigs and fixtures can be brought into a more uniform line to obtain safety, comfort, and time in handling, for instance, a standard type of handle to be used for certain movements of the jig or the fixing ; also, a certain type of knob indicates a certain type of action. The use of the single acting clamps, toggles, etc., would give security with less fatigue, cheapen manufacture, and advance safety.

Paper on COULD WE OBTAIN CLOSER CO-OPERATION TOWARDS STANDARDISATION THAN ALREADY EXISTS? By W. N. Ellerby, M.I.P.E.

IN saying a few words on Standardisation, I should like to confine myself to co-operation. While many phases of standardisation have been touched upon to-night, it is essential that before any of them can be successful there must be co-operation between the various sections of our industry; in the first place between the several departments of one organisation, and secondly, between the several organisations which make up our industrial system. Just as team spirit is essential to the prosperity of any single organisation, so do all great improvements in the productive power of industry depend upon co-operation, and it is along the lines of standardisation and co-operation that engineers in the future must look, if real economies and progress are to be made.

Is it possible to obtain closer co-operation towards standardisation than already exists?

Yes, if the manufacturers of this country would get together and discuss fully the benefits that could be derived from standardisation. While we will acknowledge the benefits, the engineering industry has received from the B.E.S.A., S.A.E., and S.M.M.T., I think that manufacturers could use those Associations more than they do at present! Already we have the Employers' Federation who meet from time to time to review the human element in industry; could not this organisation be used to discuss the wide application of standardisation along material lines as could be applied to the several branches of engineering? The engineering world is divided sharply into several distinct sections, and I see no reason why the employers of these sections should not get together to discuss this all-important subject. The machine tool manufacturers, for instance, could get together with a view to standardisation of the common parts of machines, also the tool equipment which they supply with their various machines, while at the same time they could each and every one keep the essential or special features of their own products without affecting efficiency.

The grinding wheel suppliers, during this last three or four years have held many discussions with the idea of reducing the colossal numbers of grits and bonds of grinding wheels, and the standardisation of bores, and I believe that they have got so far with the standardisation of the bore diameter of certain wheels and can get no further until the machine tool manufacturers are brought into co-operation.

Here is a concrete case where industry would benefit if the parties concerned co-operated with the idea of standardisation, and there is no reason why they should not. The standardisation of tool equipment would save the production engineer many hours of thought as well as save him money when laying out new plant,

The previous speaker touched upon internal works standards. Well, this is as important to individual firms as general standardisation is to the industry as a whole. For instance, we should have more co-operation between the design department and the shops which would enable us to get simpler designs, or designs that can be economically machined and assembled ; here, limits play a very important part and a standardised list of limits should be adhered to. In addition, no new design should be stabilised until the production engineer passes it O.K., as often a very slight alteration to the design would save new machinery being bought, or enable existing machinery to be utilised. Co-operation between departments in this manner is essential to enable engineers to standardise their equipment in the workshop.

Co-operation is essential and necessary between all parties if standardisation is to be of benefit to the engineering industry, and I think that this Institution, in arranging this discussion in all its branches, is doing valuable work in this direction, and when all the various views are collected together and printed, it should not only form interesting reading, but the information should be of immense value, not only to members of the Institution but to the engineering industry as a whole.

Paper on IS IT POSSIBLE TO FORECAST LINES OF ACTION FOR STANDARDISATION IN THE FUTURE? By C. J. Potts, M.I.P.E.

THE essence of standardisation in engineering production being economy in time, labour, and money, it is obviously a most desirable condition. To bring standardisation into practice for the benefit of engineers engaged in the manufacture of mechanical assemblies, it should perhaps be made a definite function of this organisation of production engineers. To what extent we can collaborate with other engineering institutions and finally with the British Standards Institution in regard to standards for raw materials and finished products generally supplied to the automobile and kindred industries, is not clear at the moment.

At the outset it only seems possible for us to act in an advisory capacity, since our membership of persons in a position to put proposed standards into practice would be insufficiently strong to influence the industries affected. As our membership covers iron, steel, machine tool, heavy and light engineering trades, obstruction in this work could be expected from both within and without this Institution.

Discussion is simplified if confined to one industry, and for the purpose of this paper, I take the automobile industry.

The first requirement seems to be for a central standards committee to publish, in abbreviated form, all existing standards relating to automobile production. If this could be done in one book, it should give an impetus to the adoption of standards already made, and would at least bring us up-to-date in this respect.

Machinery could be put into motion for ascertaining the industries' requirements, or, shall I say, difficulties in obtaining supplies, for the drafting of provisional specifications as a working basis for subsequent discussion, by section committees, for guidance in making recommendations to the British Standards Institution. Representation on the appropriate British Standards committees should be sought, for obtaining the necessary authority for the adoption of these standards by the industries affected.

Inquiry may be under three headings, viz. :—

(*a*) Works routine.
(*b*) Raw and finished materials.
(*c*) Design of products in common use, but which are of minor importance in automobile and machine tool assemblies.

The adoption of standardisation within a particular business is to-day almost a vital condition for its existence and success. Since

a fair number of business concerns already have their specifications a fair amount of progress could be made in a short time by an effort to unify current specifications into general standards. These efforts could be in the direction of standardisation for materials (enlarging upon existing specifications which primarily give chemical and physical properties), machine attachment fitting dimensions, and universal cutting tools and adapters. The immediate benefits of standards on these would give me greater interchangeability in sources of supply in the case of materials, and interchangeabiliy of units to machine tools.

Facilities for publishing in our journal, matter relating to standards by members should be provided, in the hope that varying practices may in time become more uniform and ultimately standardised. Indeed this may be considered the most important matter at the moment since we are only concerned with ourselves, whereas standards must receive the general consent of producing and consuming industries before being adopted by the British Standards Institution (or B.E.S.A.).

It is obvious that a vast amount of work is entailed if standardisation is to be a line of action for this Institution. Also that its goal is more in the interests of the employers of production engineers than to production engineers themselves. It may be argued that such work to be really effective is too great for a voluntary effort, and so the question of support to this Institution by engineering firms is raised. I am not unmindful of the support of industries to the work of the B.S.I., which I consider leaves plenty of scope for support to our own efforts.

A few items which require consideration are mounting dimensions for electric motors and starters, standard taper for all socket fitting tools, dimensioning and spacing of slots in machine work tables (according to type of machine), dimensional tolerances on strip and tube materials, and layout of drawings in respect to production, dimensioning, and indication of finishes. These items would not be subject to variations, and should be of much assistance to suppliers at the time of bringing out new products.

To sum up the prospect of the adoption of standards for the benefit of production engineers, it would only be successful in proportion to the extent to which production engineers can insist on their adoption.

Discussion.

MR. AIERS: Mr. Drane opened the meeting and gave a definition that standardisation should go by public opinion. I think this is very dangerous. Motor car firms are supposed to change the model each year. That, I think, is the dead opposition to standardisation. Even though you do not advocate a thing yourself, if the public want it, you have it.

Mr. Cole gave three headings: "How it was going to help the country, then the public, then the production engineer." Let the production engineer come first, because if it is put up to the country first, you might not get far.

Mr. Griffiths mentioned the point that at a turbine factory they made one jig which was standardised, and able to be used on various parts. Would you suggest making a costly adjustable jig if you were making thousands of the parts, because, of course, a simple one would be cheaper. It brings the fact to light that if you are dealing with single items, or with parts in mass production, you have got to use entirely different methods.

Mr. Potts mentioned that the tool makers do not appear to have any standards. I think they have standards, but the limits are so high that they dare not publish them. I think the biggest point to stress is that if we do want these standards we must co-operate with the B.E.S.A.

MR. DRANE (Chairman): The word I had to describe was "Standardisation." I said that the nearest word to standardisation is the word standard, and I maintain that the word standard, or "a standard" is that which is established by public opinion or rule. I say quite definitely that public opinion does establish a standard, and my definition of standardisation is an act of conforming to an existing model or rule. I did not bring public opinion into standardisation.

MR. TIPPLE: What I would suggest about standardisation is that we must not make any new standard without very careful investigation of existing standards. The Americans have issued gear teeth standards; we have issued our own with B.E.S.A. and we now have three standards for gear teeth. The question of dimensions on drawings strikes me. Again, I think that common-sense should dictate the standards. Ten feet in inches I think is overstepping the mark. I have always been accustomed to going up to 24-ins.

A little while ago I was concerned with standard sizes of sheets. We had a standard size sheet, but we were always buying in rolls. We went into the question as to whether we should have them

printed, but the price for printing was very expensive and it had to be ruled out. I asked the price for buying single sheets, and we saved about 15 per cent. buying it already cut in single sheets, and we never had the draughtsmen cutting off pieces that were out of square. These things appear strange on the surface. There is plenty of scope for standards ; certainly it is about time that we got the standardised machine " T " slots. When we get together to try to do it, everybody is concerned about the expense to themselves. I think standardisation will come by manufacturers demanding these things.

MR. BOYES : I see B.E.S.A. specifies for lead " Ld."—lead in its commercial term and not a mixture of lead. As regards the dimension Mr. Tipple has referred to, I am glad you have reminded me of that. I have not seen the dimension of 24-in. of recent years, perhaps because I have not been so closely connected with the industry. I mentioned 10-ft. so as to give a wide field for everybody to have a chance.

I fully agree that it is a matter for all people who are thinking of standardisation to consult the various specifications issued by B.E.S.A. Five hundred are available and they cover a very wide field, and it is for everyone to practise and put into action these various standards as internal works standards, and then I think, after a period of time, the public opinion would rule them as serviceable.

MR. BLACKIE : I do not quite agree with Mr. Aiers that the production engineer should set the standard. In a factory this certainly applies, but when it comes to the public, I think the public definitely lead the way. We have only to look at the motor car body. The production engineer would perhaps like to have one great big factory turning out bodies for cars ; would the public stand it ? I do not think so. The public would definitely want something which was different from anybody else's. They ask for it, and the firms must do it, or else they do not get their money.

MR. SIMPSON : I think the object is to put forward to our Council the lines they should follow in bringing this standardisation forward. We know that all good firms have internal standards for the drawing office to follow, and also for the making of jigs, etc. To my mind it wants generalising.

MR. MURRAY : Mr. Cole brought in the very fixed and debatable question of the metric system.

You have all been discussing the question of standardisation from the point of view of new work. There is also the question of standardisation of repair work, which is a subject quite apart. It is a very real one to certain branches of engineers, but I do not propose to go into it as it is a subject in itself. With the electrician I think we have probably the best illustration of what can be done, when you get various people who have their own ideas and their own regular

companies jointed together under one heading. As long as we have individual manufacturers we are bound to have a difference of ideas as to the detail parts.

Mr. Cole mentioned tappet barrels. Is it suggested that tappet barrels should be common for all types of motor cars ? In regard to the question of standardised drawings, I know of one drawing office where standardised printing is taught. This is very fine. The multiplicity of letters and figures for identification purposes on drawings. I counted in Coventry, some months ago, 95 letters and symbols for identification purposes. When we begin to substitute colours, it is astonishing what we can do. The blue print can be abolished. Instead of having the drawing, if you have one sample of your article painted in colour, you can get all the information the drawing gives to the operator.

MR. HEY : I believe, before machine tool makers standardise their machines, I shall be busier than ever. I have always found that however standardised a thing is, customers want a special machine. I had an inquiry a little while ago for an automatic machine, which I found had been made on the Continent for some ten or twelve years. This had been obsolutely standardised by about three firms—they had standardised the speeds, cam motion, bearings, and practically everything about the machine. I took one of these machines and found that the speed was about 5,000 r.p.m. I had run over machines at about twice this speed without trouble, and did not see why we could not do the same in this case. I built a few machines to order, ran them at double the speed, got double the output, and very nearly double the price. That is a case where standardisation had kept that machine back simply because those three firms co-ordinated.

The point comes that standardisation, as I see it, is in the smaller details such as nuts, bolts, screws, etc., but I do not see how we could standardise the machine itself to be successful. As soon as standardisation of turret lathes comes in, so that every one is a replica of the other, competition comes in and it gets back to stagnation. The car trade is the same. Individuality comes into it, and I believe that whoever standardises to that extent will find that they come out of business.

One point which occurred to me was the question of oils. It is most difficult to know which oil to use nowadays, and this is one thing which needs standardising. Working to B.E.S.A. limits we find that with a certain oil we can get good results. If the oil is changed the workmanship will not pass inspection. So many elements enter into standardisation, that it is very difficult to decide where it should start and where it should finish.

MR. AIERS : We must not take standardisation too seriously. I was just wondering whether we have the name right. If we sug-

gested, say, simplification, or simplified products, and then thought of it under that heading, should we not be getting nearer the mark? So far we have not put forward any concrete suggestions to the Council of parts we should like standardised, and how they can carry on the work.

MR. SIMPSON: In machine tools the idea is to make the machines so that you can interchange the parts and arbors on these machines. I take it that it is only to make the tools or arbors more applicable.

MR. ELD: The point which appeals to me is that the question to be settled is one of standardisation of methods of measurements, and if you think that over, you will see what I mean, and I think the answer to that question would answer the difficulties which have been raised here to-night as regards standardisation.

One speaker mentioned the great number of limits you have, and methods of measurement in the trades, dealing with engineering generally. You get tool manufacturers, sheet manufacturers and steel manufacturers all using different types of gauges applying to the same materials. In regard to wire gauges, you get about half-a-dozen different names covering these. The point is which of those standards or gauges can be cut out with advantage, and when this society as a whole has decided along those general lines, which they consider are the best and most useful measurements to be used in the trade, they should forward their recommendations to whichever body can make the greatest headway, with their recommendation along those lines.

MR. TIPPLE: In regard to wire gauges, I had this trouble with wire gauges, plate gauges and sheet gauges not long ago, and I was so disgusted with the numbers of draughtsmen who said that in the Machinery handbook there were six or seven, that I thought I would try to settle it. I wrote to three manufacturers in this country saying that in future we proposed to work to one gauge; which type and which gauge was their standard? All three replied saying "English imperial wire gauge," and these are now being used.

MR. BOYES: I am glad Mr. Tipple has mentioned this point, because it cropped up some years ago. In regard to brass, I was in a rolling mill watching some metal being put through and I asked for a sample for testing purposes. I asked the foreman roller what wire gauge was used and he did not understand me. I asked the standard, and he said it was their own standard. I found eventually 15 different gauges for measuring copper, brass, etc. I wondered why we could not have these standardised, and I am very pleased to hear that they are being adopted.

MR. GRIFFITHS: The paper as outlined asked for an analysis. Internal work standards will always take preference over national standards. More power should be given to production itself.

MR. DRANE: For many years we have been striving to get

the very things we are discussing to-night. I do believe that to a certain extent standardisation restricts production, and I agree with Mr. Hey's remarks in that direction. The names of parts and these various signs, of course, are always in the minds of drawing office people. When you said Ld. I thought immediately of light drive, because that is our standard way of putting it. Years ago we made a standard that over 2-ft. should be in feet and inches, but below it should be just the inch mark, because previously trouble has been experienced.

The question of blue prints is most interesting. I was very interested to hear about the colour scheme. Regarding the issuing of blue prints to the shop, I am convinced that this depends on the product, and where you have mass production you have a standardised product, and I am sure it pays to take each individual detail and make it a separate drawing. Standardisation, to my mind, should start in the drawing office.

VARIOUS ASPECTS OF STANDARDISATION.

Four Papers presented to the Institution, Manchester Section.

Paper on PRODUCTS, by H. Jinks, A.M.I.P.E.

IN this short paper I have purposely avoided dealing with the standardisation of machine details in favour of the more difficult subject of standardisation of whole products, and I have endeavoured to touch upon a sufficient number of points to provoke useful discussion.

The standardisation of products offers the benefit of lower prices to the consumer but reduces the field of selection to suit personal fancy. As the customer is the ruling factor in the long run, attempts at standardisation must, in order to be successful, take full account of this factor. It is futile to standarise only on the basis of manufacturing cost and convenience even though this may result in the cheapest final product. The customer certainly wants cheapness and efficiency but also, in most products, he requires some satisfaction to his aesthetic or, shall we say, non-practical tastes. For example, an attempt to standardise colour in a product in which colour plays no part in efficiency may place the article at a disadvantage in the open market.

Therefore a standardisation scheme must satisfy customers' tastes and provide for general tendencies so that the final product shall be current or fashionable for a period sufficiently long to show an overall profit on capital outlay. In marketing a standard article to give general satisfaction at low cost the market must be studied and plant laid down to give the full benefit of cheap production based upon estimated sales for a period ahead.

The degree of accuracy of the sales forecast generally determines the success of standardisation. In an accurate forecast the customer's tastes, his technical needs and the trend of contemporary design must be carefully studied. Even the most careful scheme of standardisation may be brought to naught by unforeseen improvements or inventions and it is essential that these contingencies be borne in mind by providing as far as maybe, a degree of elasticity in the manufacturing organisations.

Standardisation must not hinder the progress and development of new designs; it certainly cannot stop progress. I think we

should look upon it as a living thing; always undergoing development, always we hope, moving forward, never reaching finality. If the merit of an article is sufficiently outstanding it induces a degree of standardisation by the elimination of less satisfactory alternatives. Even in these cases, however, it is only a matter of time before new developments oust the old designs.

Most of us are too prone to consider standardisation as a final immutable thing, especially when we have assisted in creating or attaining a particular standard. It cannot be too strongly urged, however, that in standardisation the time factor looms large and that scheme is best which at the outset provides for revision, expansion, contraction or other modification. Indeed, I think it is a virtue to sweep away obsolescent standards. There is much harm done to the cause of standardisation and much inconvenience to the public during the lingering departure of a dying standard.

In most engineering products we are generally guided and circumscribed to a large extent by the principles of machine design. Calculable stresses have to be withstood by the product as a whole; empirical rules govern provision for wear and indeterminate forces. Different designers may arrive at similar values for the stressed parts and yet vary widely in their scheme of arrangement. In one scheme compactness may be the dominant note; in another, accessibility; in another, appearance. Each of these qualities will influence a buyer according to his training and mental outlook. Each has a decided market value and, too frequently, each is antagonistic to the others.

A shrewd designer who is able to reconcile these qualities will appeal to a threefold market and, in my opinion, successful standardisation must achieve that reconciliation. It is not enough merely to ensure interchangeability of products. It is an attraction and an advantage to be able to interchange the products of several firms or the various products of the same firm but the advantage is not supreme. It is always liable to be outweighed by more striking advantages in another design, standardised or non-standardised. Therefore, I say, it is most important to provide machinery for keeping the standard up-to-date.

In engineering circles the standardisation of products is usually most important when the products of different firms are associated in final assemblies. For example a machine tool maker must make provision for motor mounting, for tool and fixture carrying, and for conversion of the machine for varying purposes, all of which may involve the products of any one of a number of other manufacturers. A motor manufacturer must provide for various types of transmission—chain, belt, clutch, etc. which affects the design of his product. Tool manufacturers must provide for innumerable types

of holders and users' fads. There is no doubt that in these and in many other cases it would be a boon to arrive at common standards for use throughout the trades.

We are probably all agreed that some measure of good results from standardisation of products. It is relatively easy to standardise one's own products but it is an entirely different proposition to reconcile the self-standardised products of competing firms. The question is, how best to promote this higher degree of standardisation ?

The first and obvious way is to make the fullest possible use of the work already accomplished by the British Standards Institution. Their specifications are available to all at small cost and every firm should possess copies of those specifications which affect their own work. I do not know whether the Institution publish their various specifications in collected form but I think it would be very valuable to designers and to engineers generally to have the standards in book form for easy reference. Some of them are already included in the standard reference books but they are worth a book to themselves.

The second way is to assist in the development of further standards. A considerable time often elapses before it becomes generally apparent that a particular product or form of product should be standardised and by that time owing to the commitments on account of existing designs, the various manufacturers will be loth to make any appreciable changes. Obviously, the sooner the need for standardisation is discerned the easier it will be to bring it about. Therefore we should aim to encourage suggestions and constructive communications from all competent persons on the subject and to provide advisory bodies which would make recommendations to the British Standards Institution or other official associations.

It may be argued that the existing organisations already provide for this but I do not think they are sufficiently in touch with individual engineers and, after all, a good idea is always apparent to an individual for some time before it is generally acknowledged and accepted.

When an official standard specification is published its recommendations are generally adopted tentatively by many firms, usually by modifying their previous designs and marketing as an additional type. Thereafter the degree of popularity of the standard design as shown by sales returns decides whether and at what rate the old design shall be abandoned in its favour. Should its popularity be found insufficient to command a reasonable sale after a certain period the standard should be reviewed and modified or officially abandoned. It would no doubt be exceedingly valuable to the standardisation committees to know to what extent its recommendations were

adopted after periods of say, 1, 3 and 5 years and this would necessitate the close co-operation of the various firms affected.

I have in mind a scheme in which each firm would appoint an individual to correspond semi-officially on matters of standardisation with a central body so that investigations could be carried out more rapidly, and our members would seem to be admirably suited for this work.

I will conclude by insisting that the work of standardisation should not be left apathetically to the central bodies but should be helped forward as a duty by each one of us, preferably through the medium of our Institution.

Discussion.

MR. T. FRASER (Section President) in his opening remarks stated that it would be a good thing if customers could be trained to ask as far as possible for standard articles.

MR. F. W. SHAW made a statement concerning the work of the Engineering Standards Institution referred to by the lecturer in his paper, *i.e.*, they do definitely ask in their publications for suggestions and they do publish some of their work in book form.

MR. HOOD referred to Mr. Fraser's comments on the training of customers and said that he considered the sales people were the people responsible for this.

MR. NICHOLSON said that he had some knowledge of the attempts which have been made concerning standardisation, and although he would not like to discourage anyone in any way, he would like to indicate the obstacles likely to be encountered in engineering standardisation. Mr. Nicholson then referred to a period after the War when electric motor manufacturers (his company being one of about 70?) went out to standardise motors. He said that no more enthusiastic body of men ever got together to standardise as at that time and they worked hard for several years. The result was the standardisation of brushes—not a great result for a lot of effort. Mr. Nicholson thought that the reason is, that various companies resist standardisation unless it happens to be standardisation of their particular product ; they all agreed to standardisation provided the final result did not change any of their designs. That was no good at all and did not lead anywhere and it was a waste of time. One of the main difficulties was to get people to realise that they have to give something. In this respect Mr. Nicholson mentioned the value of an Institution like the Production Engineers in gathering together the representatives of various companies, and said that it was necessary to start out recognising that there is a big obstacle and then plough steadily and thoroughly . . . . . Mr. Nicholson assumed that the first part of the programme referred to general standardisation of products. He said we may not go to the extent that Mr. Ford has done, but between where we are to-day and where Mr. Ford is there is a medium we want to aim at, and we must work away to get as far as we can towards overcoming the obstacles.

MR. JINKS referred to Mr. Fraser's point about the training of customers and said that as far as he had been able to find out, the worst customers are those who originate standards themselves—they do not take advantage of the standards available, and perhaps the greatest offenders are the engineers. It is up to the

engineers to do what they are preaching. Mr. Jinks said he knew that the British Standards Institution ask for co-operation, but he himself would hesitate before writing up to them, as it seemed such a long way to go to put one's ideas forward. He would like it to be through their own domestic organisation in the Institution and he believed that a lot of people would prefer that. Referring to the very important point mentiomed by Mr. Hood about training salesmen to push standard articles, Mr. Jinks considered that standardisation on the lines he had laid down, while he knew that it was difficult to standardise so that all the good points are brought out, would be one of the best points that a salesman could have and the product would help to sell itself. He did not think that the salesman would have to push it—the advantages would be obvious.

Mr. Nicholson had mentioned the point about manufacturers always being very glad to standardise and yet always wanting their own fundamental design accepted as the standard. Mr. Jinks said that of course was very common and was often found even in a works' standardisation scheme. Everyone goes to the meeting ready to standardise but they all want their particular part to remain unchanged, and in cases like that it helps very much if an existing standard is adopted as far as practicable, even if all the firms do not agree to turn over to it entirely. The customer is the final arbitrator in these matters and it is no use standardising at all if you cannot sell. If you give the customer some definite point of advantage, he is likely to specify it, and the firms who want their own articles standardising will have to come into line.

Mr. Leslie said, in regard to the points raised about the customer and the salesmen, that it seemed to him necessary to bear in mind that each manufacturer goes out for certain characteristics, as in motor car manufacture; for example, it is possible to name the manufacturer of each type of car that one sees about. He thought that was the definite line that various manufacturers take and intend to keep, so that their own products will have some personality peculiar to themselves. He considered that if we failed to achieve standardisation of the product as a whole, we could still go ahead with some of the principles,—on the electrical side, phases and voltage, and so on, and on the mechanical side, steam pressures, and he suggested that a lot could be done there. Mr. Leslie also made a suggestion, on the electrical side, and that was the standardisation of switch boxes, cables . . . as they are a source of trouble on almost every electrical machine.

Mr. Hyland, in referring to Mr. Jinks' statement that very little good could come from any standardisation scheme unless the forecasting was accurate, asked if some information could be given on how to forecast accurately.

MR. JINKS, in replying, said there was not time to answer Mr. Hyland's question in the way that he perhaps wished it answered. He had this idea in his mind, that unless you forecast your market, you do not know whether you are standardising something that will be on the market after twelve months or two years. It is no use standardising unless you forecast, as you may find that a product is out of fashion and not wanted. If your forecast was wrong—if you were too optimistic—then it would mean you had created a redundant standard, and that is done to-day, and the trouble is that people are inclined to let it stop at that too long; as soon as it is found to be redundant, people should be as quick at getting rid of it as they were at starting it.

MR. HOOD said that he had read a few weeks previously some statistics on the glass industry. Twenty-five years ago glass was manufactured on similar lines to the way in which it was manufactured in the old Egyptian days. To-day it is manufactured by machinery, by various standard methods, and the average output per man is known to be about five or six times the amount, not necessarily due to the fact that glass is any more standard to-day—it is probable more variable in its size and dimension—but production methods have become more standard and thus make the production much higher.

MR. T. FRASER agreed with Mr. Hood's remarks to the effect that the methods in the workshop should be standardised, and he considered that before the methods are standardised, one should know what one is going to manufacture.

Paper on METHODS, INCLUDING PATTERNS, by J. Hood, M.I.P.E.

MUCH has been said and written regarding standardisation in industry. I propose with the very short time at my disposal this evening to put forward a few facts regarding *Practical Standardisation*, as applied to the *methods* in the engineering trades to-day.

You have been told to-night of the saving that can be made by *standard tools, drawings, materials, etc.*, but *standard methods* of *handling, procedure* and *service*, not only save considerable time and money, but a great deal of *inconvenience*.

Whatever the standard adopted to get work done, or the maximum amount of effort resulting in greater production, it is of paramount importance that there *must be* a definite understanding of the methods involved.

A number of institutions have dealt with research on standardisation, and from time to time publish a pamphlet, in which they give details of their findings so far as it affects this subject. An attempt is being made to form a *national standard* of *abbreviations* in standard terms, so that all drawings, books, treatises, etc., will have standard engineering abbreviations understood all through the English-speaking engineering world.

The aim of a production engineer is, as far as possible, to obtain maximum efficiency under existing conditions ; this can be influenced in no uncertain manner by well-thought-out schemes for *methodical standardisation*.

Planning and its Relation to Production.

Factory and production planning covers such a wide and varied field that, I venture to state, it would be impracticable for such a department to function solely on *strict stereotyped* lines. Rather should it be, at all times, prepared ruthlessly to overrun any system or standard practice, when by so doing, some improvements *can* be made. At the same time the majority of production planning can with advantage be dealt with by standardised methods :

(1) It will be appreciated that in every class of engineering, whether on *batch or mass* production lines, there are many components of a similar nature. I suggest that a standard operation layout be prepared ensuring that all such similar parts are dealt with in the *same way*. Quoting standardisation of machine tools for instance, to enable the planning department to function on efficient lines, they should also determine the particular machine

to be used, as well as the *modus operandi*. In order capably to deal with peak outputs, it is an obvious advantage to have several machines with the same *capacity* and *features*, so that the necessary jobs can be transferred to other machines when the machine for which they were planned becomes overloaded, thereby avoiding duplicating and locking up expensive equipment. I realise that in many cases perhaps this procedure is not to be recommended, but where output is liable to fluctuate, none can doubt its usefulness.

(2) In engineering shops, particularly where quantities are small, there should be some standard means in existence whereby the layout and particulars compiled by the planning department are passed on to the actual operator in the shops. A simple yet effective means to this end is for a copy of the operation sheet to be pasted on the back of the drawing of the component. The operator then is able, when studying the drawing, also to see at a glance what his particular operation covers, and the important features relative to it.

(3) Standardised time studies, relative to handling as well as machining, will also prove invaluable to the capable planning engineer, as he traces over the various processes required, on a part of its manufacture, to try and determine the one to be transferred.

(4) The standardisation of *materials* used in the manufacture of any product will be of great advantage to those responsible for planning the manufacture of the parts, as well as the works in general, particularly the heat treatment section.

(5) Standard schedules or specifications should be issued by the designs department to the works giving each and every part used on each unit or machine. From these the works can quite easily regulate supplies, plan judiciously, programme, control, and assemble.

Instructions to Shops.

In order to obtain the best results from the machine and assembly shops it is of vital importance that they should be furnished with as much information as possible. If this can be done by standardised instructions, it is an obvious advantage to do so.

(1) The component drawing or print is the thing of most importance to the operator, and above all this should be kept *clean* and *complete* to the finest detail. A few *minutes' work* on the part of a *designer* can often save *hours* in the *shops*. A standard system of finishes required should be fixed and each drawing should be clearly marked to show whether *rough finished*, *ground* or *polished* faces are required. Grinding allowances and full heat treatment data also should be quoted where necessary. *A*

careless or badly prepared drawing is largely responsible for scrap work, endless delay and unnecessary worry.

(2) A standard system of limits for *plain diameters*, and *screw threads* should be introduced, for thereby much confusion can be obviated and small tool and gauge costs can be reduced to a minimum.

(3) The operator before starting each job, should be supplied with a list of equipment to be used, and also the piecework time allowed, so that no delay is experienced. This should be clearly shown on the operation sheet.

(4) Standardised methods of procedure should be in existence for dealing with *alterations and complaints* in order to ensure *prompt attention* and *settlement*.

(5) Inspection staffs should be carefully controlled for it is they who hold the reins of a standard product. Instructions to inspectors should be most *clear and concise* as it is often found useful to send out regular memos calling attention to items of importance and giving helpful information to clear up doubtful points.

(6) A standard method of issuing tools on checks to the men, is a distinct *time saver*, and makes a man responsible for his equipment. A tool tab carrying a description of the tool, and placed on a board against the man's check number, enables the storekeeper to tell where all his tools, drills, and reamers, etc., are in the shops ; and when an employee is leaving, it is a quick method of telling what this man has out on his checks, and saves the time looking through the tool bins. A *standard method* of *renovating* tools, jigs and fixtures, before being returned to the bins for re-issue is vital.

Transport and Service.

If an analysis were taken in the average machine shop of the amount of waiting time which an order undergoes, during its course of manufacture, I am sure the result would be startling. I do not of course refer to the *mass production* factories, where parts are dealt with on the line machining, and machine tools are solely employed on one operation, but to the *batch production* shop, where transport of materials demands constant attention in order to avoid undue delays.

Suitable size boxes should be standardised so that one type of truck only is required, and where possible machines should be laid out in such a manner that the standard trucks and boxes can be moved around the machine enabling the finished work to be transported and the rough material to be placed ready for the operator, thereby saving considerable amount of man handling labour.

In order to avoid delay and accidents, it is advisable that central gangways through all shops should be plainly marked and these should always be left clean. Nowadays before any article of value is purchased it is customary to make exhaustive inquiries in regard to *service*. I refer particularly to wireless sets and motor vehicles, machine tools, etc., and such like standard products. Servicing your product is now daily becoming a feature of more and more importance.

(1) Standard methods should be adopted to deal with all complaints, or requests for replacements, and accurate records should be compiled showing parts giving most trouble; from these steps can then be taken to modify the design with a view to overcoming the trouble.

(2) The standardisation of oversize or undersize wearing parts is also essential, and adequate stocks should always be available.

(3) Crankshaft grinding for instance—a standard oversize chart, whereby it is known by the operator that the nearest size to which the crankshaft can be ground, knowing that there are bearings already finished machined in the stores to suit, will give quicker service than if it is left to chance, and a series of sizes down to the lowest safety line, will ensure the fullest satisfaction and enable manufacturers to give quick service.

Patterns.

Of all the departments required to comprise a works organisation, I think the one least in our minds, is the pattern shop, and it is for this reason that I decided to mention it specially, for even here can standardisation be adopted with advantage, and I wish there were more time to go into detail.

(1) Bases, ribs, radii and dowels, should all be standardised in a few *regular sizes*, standard thickness of timber planed with one square edge ready for marking out, is a distinct advantage, thereby lessening costs and reducing stocks.

(2) Where similar parts of varying sizes or lengths have to be dealt with, judicious handling by the pattern maker often results in the saving of much expense by making uniform patterns standard and plates for machine moulding, which by slight alterations can be used for a variety of similar components.

Standardisation from Wooden Patterns to Metal.

When complete satisfaction has been reached from the design point of view, it is better to standardise on metal patterns, which will stand the wear and tear better. It can be duplicated very easily in the case where larger supplies of castings are required,

with this fact always in mind, they can be broken up and melted, and only the loss of time spent in manufacturing is incurred.

Conclusion.

Wherever it is possible to introduce safely standardisation of method or practice, I am of the opinion that it is a vital necessity to do so, and when routine is arranged on standard lines it will function smoothly and efficiently. With this proviso : any system which cannot be elastic to some extent is worse than useless. I am convinced too, that simple universal standards generally understood will be better both for the men and the executives, and where new employees are taken on, having worked previously under similar conditions, the more easy will he be able to get down to the job, " particularly if it happens to be a piecework shop."

Discussion.

MR. A. FRASER asked Mr. Hood whether the operation list was pasted on the back of the drawing, and Mr. Hood replied that this was so. The drawings were issued in certain sizes and the operation sheets were pasted on the back of the drawings which were already pasted on thick cardboard, and this can be stood by the side of the machine. Typing would not be an expensive item (owing to alterations and modifications) as they type five or six copies at once : one copy is put on the back of the drawing, and one goes to the rate-fixing department, one to the planning department, and various other departments. This keeps all departments up-to-date.

MR. PUCKNELL said that they had a most excellent exposition of the engineer's dream of Heaven. He agreed entirely in principle with the standards outlined, but he would like to ask Mr. Hood one question. In a factory which one will assume for a moment could work on Mr. Hood's theoretical system, does he not think that the number of non-producers would be so great that the overhead charges would make it impossible to sell his products ?

MR. HOOD said that in large engineering shops one cannot afford to be without these operation sheets, as they prevent scrap, and the amount of scrap that was prevented would outweigh the cost of working on standard lines. In a small engineering shop it was obvious that someone must start the job, and of course someone must put it into the shop. In their case it is just as easy for the foreman of a department responsible for the job to compile that data for future reference and give definite instructions to the shop, providing that records are properly kept for future reference.

MR. SKIPPER asked Mr. Hood what he meant by a uniform pattern.

MR. HOOD, in replying, said that there are a number of patterns to-day that are thrown on the scrap heap which by judicious care and handling by the patternmaker could be utilised for making similar jobs, and in many cases perhaps it would only mean an alteration to the core. Also, patterns could be made which with some careful handling could be made useful for other jobs, and standard moulding plates, whereby you could transfer various patterns with holes drilled relatively in certain lines, so that you could take your pattern off and replace it with another. Mr. Hood considered the amount of work in pattern shops excessive owing to lack of co-operation, and suggested that to do this on standard lines is well worth very careful consideration. He had in mind definite sizes and definite thicknesses of timber, also improvers for semi-skilled work on sanding machines, and for generally cleaning up

etc., before the actual building is done ; instead of the skilled man having to do all the work he would be left to the most important parts of the layout and construction of the patterns.

MR. F. W. SHAW related an incident concerning a Lancashire firm which many hears ago went into the question of "Standardisation"—on one particular occasion they found that a pattern had been altered out of all recognition in gradual process of making the pattern do for various other jobs.

MR. HOOD suggested that there are a lot of items in the engineering industry to-day that are similar, and a lot of time and money could be saved by utilising standard patterns. He was referring particularly to the manufacture of the patterns. His theory was that we should endeavour to look upon the method of standardisation in pattern production as a means of giving us a cheaper article, then of course we could afford to cut out the time wasted searching for other patterns to alter, as the initial cost would not be worth bothering about.

MR. LESLIE considered the question of patterns a very inportant one and alluded to the high cost of pattern-work and the way in which brass stampings were received everywhere with open arms. He suggested that unless the foundry and pattern shops get together on this point they are going to be more or less out of work. Mr. Hood had referred to having several machines in a department so that work could be switched over, and Mr. Leslie asked if Mr. Hood had several machines in reserve, as it seemed very costly.

MR. HOOD agreed that he did not want to see pattern-makers go out of existence. He had found that in the pattern shops you can get standardisation in thickness of material, *i.e.*, timber of standard thicknesses so that you can build your patterns without doing much machining. Machining takes time. Very often in shops there is no plant available and a very slow process of hand sawing, planing, and chiselling, has to be evolved. Patterns could be cheapened by 40 per cent. where standard methods were used. In answer to Mr. Leslie's question regarding machines, Mr. Hood explained that what he said was, that when the planning engineer is buying machines for a particular shop, having first considered what plant he wants, he wants to realise that perhaps a general purpose machine for a particular shop is more useful than having several single purpose machines all locked up with expensive tool equipment, and that he could, with a general purpose machine, more quickly, and with less expense, get going a job that was down on production, particularly where quantities were spasmodic.

MR. A. FRASER asked the lecturer did he not think, with regard to the question of patterns, that a lot could be done by the drawing office seriously considering the designs before they came out ? He

himself seriously considers the thickness of cast iron when designing a jig (he was speaking of jigs). He considers these points with a view to helping the patternmaker. He had in mind that a drawing office could go along way towards helping the patternmaker out of his difficulties.

MR. NICHOLSON said he would like to take Mr. Hood seriously to task over a part of his remarks . He had quoted the word " Standardisation " right through from top to bottom, but actually he (Mr. Nicholson) did not think it meant standardisation at all ; he thought it meant common sense. Right through his remarks Mr. Hood's place is run on common sense methods not standardisation at all. Mr. Nicholson said he belonged to a fairly big organisation, and when he looked for something which he called " standardisation," he found himself tied to a very small sphere of action. There was the Hollerith system—that was standard. Mr. Nicholson affirmed that he, amongst others, was one of the pioneers of limits. When the limits were set for this country, they found themselves in very considerable disagreement, and when the limits system was introduced they were no longer standard ; so that although they were the pioneers in standards, they had not got standard limits. Mr. Nicholson again suggested that Mr. Hood had introduced his subject in a way that was rather misleading, and said that he would like Mr. Hood to say whether he is as " Standard " as he thinks he is. Mr. Hood said that he had attempted to point out what his idea of common sense standards really was, and that if they could get a general understanding all round of what " Standardisation " really meant then we should feel the benefit of increased production.

Paper on DRAWINGS, with particular reference to Standard Charts as means for saving time in calculating and minimising tedium, by F. W. Shaw, M.I.P.E.

THIS contribution to the Institution's "standard" subject shall start, as did a previous effort of mine, with a reminder that "the best-laid schemes of mice and men gang aft agley." For, however keen may be the discernment of those who decide upon the thing to be made, however just be their conception as to what will sell and the price it will fetch, its desirable efficiency and its aesthetic appeal, not one of these desiderata is realisable if the man at the drawing board, however competent he may be, is hampered by lacks in his department.

It is, or ought to be regarded as, a truism that freedom from worry, whatever its origin, is an essential concomitant of the best and quickest work. And one of the most prolific sources of worry, particularly when time is not unlimited (it seldom is), arises from the compulsion of draughtsmen to perform a number of time-using operations which with a little study might be standardised in such a way as to cut out that loss of time which is spent considering just how those operations are to be performed. Often, to think out the best way costs more than to follow the worst.

Now by charts, the side of the subject upon which I intend to particularise, I do not refer to those of graph type, with which every draughtsman is, or ought to be familiar, but to a kind of chart analogous to that of the mariner, a chart to show the way and make it safe to travel.

As I have specialised to some extent on toothed gearing, it is but natural that much of my study in the direction of time-saving has been devoted to this side of engineering. You will excuse me, therefore, if my illustrations refer almost exclusively to means for saving time on gear calculations. Nevertheless, the methods they reveal have very general application. To those who have not considered the possibilities of such charts, they will serve as a hint as to how similar charts for other calculations might be prepared.

(*Mr. Shaw illustrated by lantern slides several calculating charts particularly applicable to problems in gearing*).

In all these charts, which I term Standard Calculating Charts, as you will see, is printed or drawn or written permanently everything that pertains to the constant or fixed portion of any set of calculations together with full directions as to the procedure to be followed in calculating. Where the basis of the calculations is a

general formula, that formula appears in full. After the sign " = " the formula is repeated, but with its term ommitted. Where the formula is capable of reduction or simplification, the simplified form follows. Generally the second, the termless, formula and the simplified formulæ would consist merely of arithmetical signs with spaces between them denoting exactly where figures must be entered. Reference letters or small figures in these empty spaces refer to instructions, also on the chart, as to the arithmetical procedure ; whether, for instance, calculation may be by slide-rule, by a rough estimation, by 4-figure or more-figure logarithms.

Any chart may be used directly or through the medium of tracing paper laid over it. If at any future time a tracing, upon which appear only the figures actually needed in any calculation, must be consulted, the tracing is re-applied to the standard chart. Smaller charts would be printed if the number required warranted the cost. But any chart can be arranged for reproduction by any suitable process, white prints being preferable.

The more complicated the set of calculations may be, the better are the time-saving qualities of these charts. In some gear calculations, charts which I use have reduced hours to minutes, days to hours. In one particularly difficult set of calculations, a solution seemed impossible before the chart existed. As a matter of fact a valuable scheme was shelved after a good week had been spent in futile trial-and-error calculations. By the aid of the chart, solution occupies less than two hours. Moreover, when attained, it presents the very best arrangement of gearing possible. Scarcely a gear problem exists where charts of this kind cannot more than halve the calculating time.

As a matter of interest, you may be interested to learn that for many calculations, particularly for those in which the slide-rule is just a little too inaccurate, logarithms to the base 2 give a more accurate answer and are easier to manipulate even than 4-figure logarithms to the base 10. The table I use for such calculations gives the antilogarithms of all logarithms from 0.00 to 12.99 rising by 0.01, the antilogarithms beginning at 1 and ending at 8136. Some of my gear charts have been simplified by arranging them to be used in conjunction with these base-2 logarithms.

Along with the base-2 logarithms goes what I have termed an Arithmetical Series Sieve, a kind of circular calculator divided into 100 parts around its periphery, the spaces between the divisions containing the mantissae (of the logarithms) from 0.00 to 0.99. If the disc is turned through any number of similar intervals, as denoted by a fixed arrow and a movable pin, it sifts out a geometrical series, for logarithms in arithmetical progression always correspond to antilogarithms in geometrical progression. Any reasonable number

of speeds of a geometric range can be sifted out, without any calculation, in a few minutes. This system of calculation, in my opinion, is worthy of standardisation for universal adoption. Its principles, at any rate, are applicable to any system of preferred numbers, such as that of Professor Schlesinger, prepared by him for the consideration of the German Standardisation Committee. These numbers form geometric series.

In conclusion may I insist that the real aim of this form of standardisation, perhaps of most, is to perform once for all time or until better means are discovered, every operation that is common to all similar work and to compel the user of the standard to pace a definite path, carefully selected for its directness and freedom from pitfalls.

Discussion.

MR. P. S. CROOKE hoped the lecturer would have pointed out the pitfalls that most designers fall into when making their production drawings. He felt sure the majority of foremen get their blueprints sent into the factory with only half the details that it is necessary to put on. He suggested that designers pay more attention to the data they put on drawings and not leave too much to the imagination of the men who do the job.

MR. F. W. SHAW said that he was afraid the majority of designers could not do as Mr. Cooke desired without getting into trouble. His own idea in making a drawing was to supply the men in the shop with every possible bit of information. At one time he put all the limits on the drawings, and what was the result? The works told him that he was encroaching on their domain; it was not his business! He considered that the only way out of this difficulty was one that had been suggested by several speakers that evening—not co-ordination between departments, but the placing of every designing section under the control of one man. He would go even further and put not only the design department, but the production planning and process departments also under the same chief. He believed that to be the only solution of a grave difficulty that existed in the majority of works.

MR. ECKERSLEY said that he had a great deal to do with drawings in his business and he would like to suggest to Mr. Shaw that in leaving limits and other vital information off the drawings, he was asking for trouble in the shop. One essential part of a draughtsman's duty is to specify dimensions, and limits come under the heading of dimensions. A drawing should leave nothing to the operator's imagination and should give all the information possible, even to the extent of specifying in one definite place on the drawing the type of information that is conveyed: gauges should always be specified in one position on the drawing, material in another, and so on, and standard printed sheets should be used. When a man gets that type of drawing he knows where to look for his information. He considered that a man has got to know where to look for his information and that it is necessary to specify the finishes, or at least to indicate the machined surfaces of any component. When a member of the executive staff goes through the shop, he should be able to pick up a drawing and see exactly what is being done, what operation is being carried out. When a patternmaker gets a drawing of a component and sees the machine marks indicated on it,

he knows he has to make a certain predetermined machining allowance on that surface.

MR. SHAW said he was afraid that Mr. Eckersley's ideas as to what constitutes a drawing were very different from his. A drawing to his mind is just one unit, intended to convey to a particular man, or set of men, certain information ; and you cannot convey to every man who has to do a particular operation his part of the information on the one drawing. If Mr. Eckersley would say that his drawing consisted of 10 or more different drawings, he would concede the point. He had not suggested omitting any information, but simply queried the allocation of the work.

MR. LESLIE was sorry that Mr. Shaw had not dealt in his paper with the question of drawings more fully. To his mind the members as an institution, or section of an institution, were supposed to be contributing to the general question of standardisatiom. He considered it most important to get some idea of standardisation and the essentials of drawings, such as limits, finishes, and so on. Some shops go in for the decimal system, others English measurements, and others a combination of the two. He thought it essential that they should aim at obtaining what is considered the best method. His personal opinion was that they should get away from the English measurements and go over to the metric. It was necessary to get uniformity.

MR. SHAW, in replying, said that there are several opinions in English-speaking countries concerning the metric system. One of his particular studies was gearing, and in this branch of engineering the metric system is inconvenient, at least for the expression of pitches.

MR. A. FRASER considered as one of the fundamental standards of drawings that of uniformity of projection. Some shops vary the projecjection, some use English projection, others use American ; and that is one of the things that should be considered. Mr. Fraser said that he had strong views on the question of dimensioning. He felt, from the point of view of the draughtsman and also from the point of view of the man in the shop, that all dimensions should be from the important face. If a draughtsman is left absolutely free to dimension a drawing, he suits himself, and the man in the shop gets no idea whatever of what is the important face to work from. He frequently came across drawings dimensioned from the black castings, and then, from the finished face (the face that really matters), no dimensions whatever. He felt that they ought to get down to this point and dimension vertically and horizontally from the important face, or the important starting hole, such as is done in using the Genevoise jig boring machine ; *i.e.*, dimension from the face to one hole and take all other dimensions horizontally or vertically from that particular hole.

Paper on TOOLS, by H. Eckersley, A.M.I.P.E.

IN dealing with standardisation of machine tool parts and equipment, I intend to treat the subject from the users' point of view. In fairness to the machine tool companies, I must point out that this statement applies to most manufacturers of products where the customer would appreciate standardisatiom.

Standardisation does not necessarily cramp design, and machine tools of one kind produced by different firms could still retain individuality, whilst catering for the users' convenience. For instance, the standardisation of motor mountings has not reacted against the efficiency of electric motors, whilst users have been enabled to carry spare motors in the knowledge that they may be interchangeable during breakdown. Other directions in which dimensional standardisation is particularly applicable to machine tools, are spindle noses, pitch and size of tee slots, coolant and lubricant feed pump flanges, turret faces, gears and feed shaft dogs.

Chuck jaws interchangeable in any make of chuck of similar type and capacity would remove a great source of trouble and expense which most of us have suffered in silence, and there cannot be many production engineers who have not frequently experienced exasperation on finding that a lathe toolpost or tool holder requires a special size of tool shank to enable the machine to be operated at full capacity.

Motion study in a factory often loses value when a new machine tool is put into production. That the operator of a new machine must be given time to become accustomed to the new conditions is accepted in the great majority of factories as an inconvenience. Now I submit that strenuous collaborated efforts on the part of machine tool makers could effect a very valuable, if only partial, improvement in this direction, by the adoption of standard work-loading and operating positions. For instance, the height of the centres, above the shop floor, of lathes, grinders and milling machines, the height of the work table of milling machines, planers, surface grinders, drilling machines, etc., would assist considerably in attaining uniform conditions of work loading. Further amplification of this principle is possible.

For similar reasons, the direction of table traverse should be controlled by hand movement in the same direction. That is, operation of a control lever or handwheel should be from left to right for a left-to-right movement of the machine table. This principle is commonly, but not universally, adopted by machine designers. Standardised practice in the matter is essential.

I have dealt with standardisation which is external to the producer. Internal standardisation is perhaps more important and of greater interest, and in this respect great savings are possible by standardising gauges and tools.

Even if standardisation of the whole of the product is impossible, it is often forgotten that standardisation of a portion of a component is of assistance in the shops. Costly gauges can be avoided where a range of components differ dimensionally, but are typical one with another, by the adoption of quicker adjustable gauging fixtures. Care in design is essential, of course, in these cases, to avoid inaccuracies of the gauges arising out of the adjustability, but, generally, a rather more elaborate gauge will save its cost many times over, especially where the component range is occasionally extended.

We are, all of us, by now familiar with the ranges of standard planer and lathe tools on the market, tipped with tungsten-carbide, stellite, and a variety of high speed steels. These separate ranges vary considerably one from another in shape and position of cutting edges on tools for similar purposes. Standardisation here would be valuable. In my company, we have adopted a standard range based on our own practice, including tools from manufacturers' standard ranges where these are applicable. Of course, every factory will always use special tools, but it is possible to reduce the number of varieties, with surprisingly large savings in time and money. Standardisation of cutting tools means at the outset that tools can be issued from a stores, with elimination of the bad system of "every man his own tools," with costly equipment lying under benches and in cupboards.

Form turning tools are expensive, and some standardisation can be carried out here, by using built-up segments mounted on a ground bush and pinned (sketch). Each segment should of course bear a different number. Slight variations in component dimensions do not then require different complete form tools.

The fact that a standard gauge or tool is in existence, should not irrefutably be the criterion as to whether a component should be redesigned or not, but should weigh heavily against such a step. Few tools mean low maintenance costs, and standardisation of the product should be carried out with this axiom in mind. It is often cheaper and more practical to concentrate on tool and equipment standardisation rather than on product standardisation. More often a judicial mixing of the two is more valuable and more possible.

In this respect, the relationship between the product drawing office and the tool drawing office is very close, pointing to amalgamation between the two separate staffs. Even if control by one chief, with expert knowledge of both sides of the question, is not possible, a full and accurate index of available tools and gauges should always be provided in the product drawing office.

I have organised such a system with splendid results. Gauges and special tools are indexed according to the type of component and type of tool, and reference to the index by the designer of the product has saved money. It is necessary, of course, that gauge and tool numbers should appear on each component detail drawing, and should be checked by a person with authority, knowledge and the inclination to modify the product to avoid making unnecessary new equipment.

In conclusion, standardisation is not a modern fad, but a very useful production tool, and as such should be used with discretion without overloading.

Discussion.

MR. PUCKNELL said that the aspect of standardisation which Mr. Eckersley had dealt with was most valuable and should show results in tremendous saving of time and money, this being particularly noticeable in a shop where automatic machinery is used. If one has a number of automatic machines of one make, one is very chary of changing over to an automatic machine of another make, because usually the whole of the equipment that one has in the shop for the first make of machine would be totally useless for the other. In this respect Mr. Pucknell mentioned that some time ago a machine toolmaker who was preparing to put on the market an automatic machine similar to a Browne and Sharpe, had asked him what, in his opinion were the points which he should incorporate in his design. Among other things Mr. Pucknell made the suggestion that the equipment should be interchangeable with a popular type of automatic machine, such as the Browne and Sharpe. When this British automatic machine was on the market, one of the most valuable features was that the equipment was entirely interchangeable with the Browne and Sharpe machine. Mr. Pucknell stated that the firm with which he was connected bought 11 of these machines and the equipment already in the shop could be used easily on them, and he considered that this was a very valuable point. He agreed that the details of machine tool design should be made standard and said there was no reason why the tee slots in a machine tool table should not be standard, so that the equipment in one shop could be used on machine tools in another shop. Referring to turret lathes standing side by side for cutting internal threads, where one is operated with a right-handed screw and the other a left-handed screw, Mr. Pucknell mentioned a case where an operator had to go from one machine on to the other and automatically operated the second right-handed, with the result that he dug in. He considered that these are things that could be standardised easily by co-operation between machine tool makers.

MR. LESLIE said that the lecturer had to his mind mentioned a very important point with regard to tooling of work, particularly where it is applied to work which is perhaps designed for the particular order in question, *i.e.*, that engineers do not pay sufficient attention to the using of tools which are in existence. By a little consideration much money and time could be saved by avoiding the creation of new tools in some cases. Mr. Leslie considered that very strong control was needed in all works in this connection. He added that Mr. Pucknell's remarks emphasised the point made in regard to

products : that if we cannot go the whole way to standardisation, we can standardise some of the main principles.

MR. T. FRASER (Chairman) suggested that possibly the Institution could make some move in the matter, adding that the change necessary could be made so easily one wonders why it is not done.

MR. HOOD said that very often machine tool manufacturers—or anyone selling a particular article—have certain basic points to work on, and very often interchangeability is one of the points they depart from to enable them to sell that particular article with an eye on repairs and replacements. Regarding the question of starting a machine, Mr. Hood said that in the works with which he is connected there is a very fine idea, *i.e.*, the starting lever is painted red and there is an arrow indicating " off " or " on " to avoid a man getting trapped. This safety-first device was the outcome of an accident which occurred some years ago shortly after the purchase of a four-spindle machine when a man was almost trapped.

MR. ECKERSLEY said that Mr. Hood's first point raised again the question of having a special purpose man with machine shop experience whose sole purpose is just to treat with standards and to act as intermediary between the firm and some body which will govern the determination of standards. Mr. Eckersley was in entire agreement with Mr. Jinks' suggestion in this matter, as he himself knew from experience the difficulties to be encountered in applying standards. When a works manager sets out to standardise his own products, he has to please his customers, and in this respect it would seem desirable that there should be some body to give guidance to machine tool people in offering articles to the public. There does not seem to be any other way out of it, as no organisation can work well without a leader.

Mr. A. FRASER asked a question with regard to the relation between the tool design staff and the product design staff. Did Mr. Eckersley not think that the process department is the intermediary between the design office and the tool design office ? He had in mind that the product design office put a design through and sent it to the process department. Now the process department know in which particular departments this part has to be manufactured and the type of tool to be used. Why should they not get into closer relationship with the tool design office with a view to asking the tool design office if they have any particular tool which could be converted ? Mr. Fraser said that he was thinking particularly of jigs and fixtures, and that the process department will come down and put a certain design in front of the tool design office, and the tool design office say, " Yes, we have the tool in such and such a number which we can alter." Mr. Fraser again suggested that the process department should be the intermediary department between the production office and the tool design office.

Mr. Eckersley said that he entirely disagreed. In the latter part of his paper he stated that the two design offices should be amalgamated if possible, and a person with authority and inclination appointed to control the use of tools, as it is a psychological fact that if it is too much trouble to make a change, the tendency is for the person handling it to let it go through. He thought the only way out of the difficulty was to supply the designer of the product with all the facilities for knowing what equipment would be available in the shops. If you gave the designer of the product a list of all gauges that are available, he could design his product with one eye on the index of these gauges and tools and design accordingly. He should mark his component drawings with the gauges and tools he proposes to use, and one man should be responsible for checking that list against available tools in the shops, and of course the chief designer should hold one man only responsible for it. As he suggested in the paper, that man should be one who has authority, knowledge and inclination, and the latter is by far the greatest factor in the job. It is too much to expect the designer of any product to make his component details in such a way that it is possible to use standard equipment straight way in the shops if information regarding equipment is withheld from him or is difficult to obtain.

Mr. Fraser said that he was thinking particularly of a part that has been designed, and to save the cost of a new tool this particular part has been designed and the drawing sent into the process office, and with a little bit of forethought and a little modification an existing fixture could probably be used. He considered that there should be more co-operation through the two departments through the process department.

Mr. Eckersley maintained that one man's duty must be connected with just one line of work, otherwise there was a tendency to let things slide. The work of the process department should not overlap that of the design department, whose duty it is to give dimensional facts to the shops. The process department is concerned only with ways and means, and whilst the method of using the process department for this work is common, it is possibly the reason for much duplication of tool equipment. Standardisation is in the first place a one-man job, and the organisation should be such that standardisation should be used as early as possible in any shop. By that Mr. Eckersley meant that unless the use of standard tools and equipment is decided at the earliest possible moment, that is in the product design office, the chances of new tools being required are very high. Standardisation of tools must obviously be carried out from the point of view of the tools in existence at the time of standardisation, and since standardisation necessarily means slight modification to the parts being standardised, Mr. Fraser's point regarding parts already designed does not arise.

THE INSTITUTION OF PRODUCTION ENGINEERS

Index to Proceedings

VOLS. I-XII, 1921-22—1932-33

Index, Miscellaneous Contents